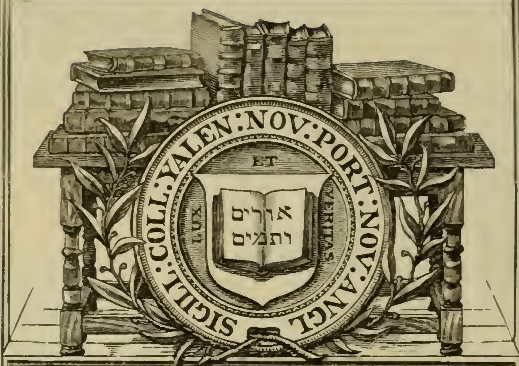

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DISEASES OF THE EAR

INCLUDING THE NECESSARY

ANATOMY OF THE ORGAN

BY
A. D. WILLIAMS, M.D
(Formerly Lecturer on Otology in the Miami Medical College)
ST. LOUIS, MO

ILLUSTRATED WITH NUMEROUS WOOD CUTS

AND ONE LITHOGRAPH

CINCINNATI
ROBERT CLARKE & CO
1873

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PREFACE.

The author presents this little book to the profession of the great Mississippi Valley, in the hope that it will be of interest to those who do him the honor to peruse its pages. The growing importance of Otological Science is his only excuse for its production.

The author does not propose to point out all the faults of his book here; the penetrating eye of his readers will discover enough of them.

In composing the matter, he has endeavored to condense everything as much as the nature and extent of the subject would allow. Trying to exclude all impractical matters, he has admitted only what he considers essential to a correct understanding of the Science of the Otology of to-day.

The author trusts that the arrangement of the subject-matter will receive the approval of his medical friends. It appeared to him that the necessary anatomy of each individual part should precede the consideration of the diseases of that part, as the most convenient arrangement of a work of the kind.

The author has confined himself mainly to his own experience, but has endeavored to state correctly the opinions of others, particularly when they differed from his own. In matters where the writer has had little or no experience, he has availed himself of the writings of others, for which proper credit has been given in the body of the work.

So far as the author knows, this is the first work of the kind ever written in the West, so that it may be said to represent particularly western ideas.

The author has had in view, in arranging the material of the book, the wants, particularly, of general practitioners and medical students. If he has succeeded in adding anything to their success in Otology, his labor has not been in vain.

A. D. Williams, M. D.

DISEASES OF THE EAR.

The Ear, the organ of hearing, is divided, for the sake of convenient description, into three parts: *external*, *middle*, and *internal.*

The external part consists of the *auricle* or *pinna* and the *meatus auditorius externus.*

The middle part includes the *membrana tympani*, the *tympanum* or *drum*, the *Eustachian tube*, and the *mastoid cells*

The internal part is called the *labyrinth*, and is composed of the *cochlea*, *vestibule*, and *semicircular canals.*

Anatomy of Auricle (auriculum).—The auricle is the outer or visible portion of the external part (see Fig. 1). It has a shell-like appearance and is funnel-shaped as a whole; its mouth looking outward and a little forward. The small end of the funnel is attached to the *processus auditorius* of the temporal bone by firm fibrous tissue, forming the outer part of the meatus. The shape of the auricle is maintained by a thin layer of cartilage, which is folded upon itself several times in a peculiar way, giv-

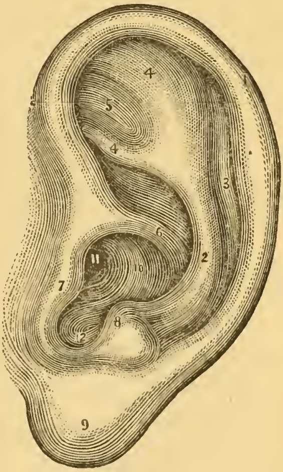

Fig. 1.

Fig. 1.—Auricle (auriculum pinna). 1. Helix; 2. Antihelix; 3. Fossa scaphoidea or innominata; 4. 4. Crura of antihelix; 5. Fossa intercruralis, innominata, or triangularis; 6. Crus, crista, or spina heticis; 7. Tragus; 8. Antitragus; 9. Lobulus (lobe); 10. Concha; 11. External meatus; 12. Incisura intertragica.

ing it very irregular surfaces of elevations, depressions, and folds, all of which have names assigned them. The outer marginal fold is called the *helix*. The curved elevation or ridge in front of, and parallel with, the helix is called the *antihelix* (opposite the helix). The deep depression between the two is called the *fossa scaphoidea* or *navicularis*.

At the upper part of the auricle, the antihelix divides into two *crura*, running forward and upward, inclosing a triangular space called the *fossa intercruralis*, *innominata* or *triangularis*.

Beginning under the front edge of the antihelix, running horizontally forward and entering the helix at the anterior margin of the auricle is seen a well-marked ridge, and, as it seems to be the starting point of the helix, it may be called the *crus*, *crista* or *spina helicis*.

The antihelix surrounds a deep, spacious cavity, which is called the *concha*. The crus helicis crosses the upper part of this cavity, which leads into the external meatus.

In front and overlooking the concha is a round-pointed projection, looking backward, and partly obscuring the mouth of meatus. This is called the *tragus*, because it is sometimes covered with hair like a goat's beard.

Opposite the tragus, pointing forward, is another projection, which is called the *antitragus*. Between the two there is a deep fissure, the *incisura intertragica*.

Below these is the lower pendant extremity of the auricle called the *lobulus*, which contains no cartilage and consequently is very soft and pliable.

In some places muscular fibres are visible on the surface of the cartilage, but these are unimportant.

There are very few fat cells found in the auricle, and these mainly in the lobulus.

The *crumpled* condition or form of the cartilage is maintained by small ligaments, and perhaps also by muscular fibres. When stripped of these the cartilage can be drawn out into even surfaces. (*Gruber.*)

The irregularities of the posterior surface of the auricle have names corresponding to those of the anterior surface.

The general integument of the body—thinner and tenderer than the general skin—covers the auricle and adheres closely to the cartilage in all its irregularities. It dips down through the concha into the meatus and lines the entire inner surface of that canal.

The skin of the auricle contains sebaceous glands, which are most numerous in its deep depressions. Hence their peculiar secretion often collects in these places.

The concha is prolonged inward in a tubular shape, and is attached to the margin of the bony meatus by strong fibrous tissue, forming the cartilaginous part of the auditory canal, as above stated.

There are also attachments by ligaments, which run from the anterior and posterior surfaces of the auricle to corresponding parts of temporal bone.

The auricle has also three muscular attachments. These are the *attrahens aurem*, *retrahens aurem*, and *attollens aurem*. Their office is to draw the auricle in the several directions. In man, however, they are only rudimentary; and there is only now and then a person who can move his auricles voluntarily. In the lower animals these muscles are well developed; as in the horse, which can easily throw his ears in all directions.

Blood Supply.—The auricle gets its blood from the *posterior auricular*, a branch from the external carotid artery, and from the *anterior auricular superior* and *inferior*, branches from the temporal artery.

VEINS.—These correspond to the arteries.

NERVES.—The cervical plexus, the facial, the pneumogastric, and the inferior maxillary nerves send branches to the auricle. It is irritation of the nerve filiment from the pneumogastric that makes a person frequently cough when a speculum is introduced into the meatus.

DISEASES OF AURICLE.

INJURIES.—The exposed position of the auricle makes it liable to injuries of various kinds. It may be bitten off in a fist-fight. It may be shot off in battle. It may be contused by blows of fist or club, or by striking the head against solid bodies. It is occasionally the seat of incised wounds, as in fights with knives or sabres. Sometimes the entire auricle is severed from the head.

TREATMENT.—The incised wounds need only be brought together and nicely coapted, and either stitched well, or what is better, the use of the interrupted sutures. The pins will help to hold the parts nicely together. The stitches or pins must be removed as soon as the parts are healed. Extensive wounds in the auricle, when clean cut, will heal nicely and leave very small scars.

In contused wounds of all kinds, whether bitten or shot, or produced by blows, if the entire thickness of the auricle is broken and their edges irregular and ragged, the best treatment is to convert them as far as possible into incised wounds by paring off the ragged edges with scissors and then coapting them, as in simple incised wounds. In this way considerable deformity may sometimes be prevented and a quick cure effected. If this is not possible on account of extent of injury, then the part can only be kept clean and allowed to heal by granulation, with a very ugly deformity.

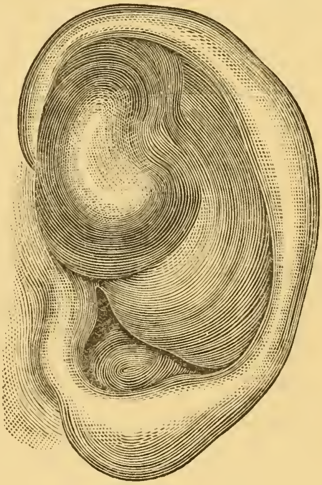

Fig. 2.

Blood Tumor.—When the auricle is mashed or injured in any way so that blood vessels in the cartilage or beneath the skin are ruptured, extensive extravasation of blood takes place, which distends the auricle and gives it a *tumor-like* appearance (see Fig. 2). Hence it is called a *blood tumor*, and, as it is the result of an injury, it is *traumatic.* Similar to this in appearance is what is called *spontaneous blood tumor* (*othætoma*) [according to Troeltsch and Gruber], not the result of an injury. Insane people are mostly the subjects of this form of blood tumor; but other persons may and do suffer from it.

But the fact that it is so frequently observed among the insane has given rise to the theory among physicians for the insane, that in these unfortunates there is a peculiar nervous condition, producing local disease, which predisposes to hemorrhage in the auricle. Some go so far as to say that, if they find a blood tumor in a person of sane mind, they may *suspect* the approach of insanity.

Fig. 2.—Blood Tumor (after Gruber)

The opponents to this theory account for its frequency among the insane, upon the supposition that they secretly injure their ears. This supposition is made plausible from the fact that the men (the most *violent* of them) are by far the most frequent subjects of blood tumors. They by nature are more likely to do violence to themselves accidentally or intentionally than the women.

Virchow, *L. Meyer*, and others believe in the theory of local disease in the substance of the cartilage or in the perichondrium. But the question is not at all settled, and its discussion is not proposed here.

PROGNOSIS.—If left to themselves these blood tumors will continue, as a rule, for an indefinite time. They never interfere with the hearing, except when they extend into the meatus. They sometimes heal spontaneously by taking on active inflammation, which causes gradual obliteration of the cavity containing the blood. This process leaves an unsightly crumpled deformity of the auricle, which is always to be avoided as much as possible. Hence, the best method of

TREATMENT becomes an important matter for consideration. It is to be regretted that the treatment is still an unsettled question. I give what seems to me to be the most rational treatment, which is *surgical* only. I have very little faith in the antiphlogistics recommended by many. Whether traumatic or spontaneous, the surface of the blood tumor should be freely incised and the entire contents (sometimes a mixture of blood and serum) thoroughly removed without doing too much violence. The walls of the cavity should then be pressed together with compress of charpie or lint thick enough to fill up the concavity of the auricle, and over this gentle pressure (but sufficient to prevent fresh hemorrhage into the cavity) should be made by a bandage horizontally around the head. The first dressing should remain till evidences of inflammatory reaction set in. Then the dressing should be taken off, the parts cleansed, and bandage reapplied. After this it should be removed as often as it seems to be necessary. The incision in the skin should remain open so all the fluids could trickle out. The object is to obliterate the cavity by bringing the opposite walls together and making them heal up. Fresh hemorrhage must be constantly guarded against till the cure is effected.

This treatment promises the speediest cure with the least possible deformity as a result.

The above treatment is, in the main, the same recommended by *Gruber* in his recent valuable work. Whatever indication there is for general treatment should be met in a general way.

SEBACEOUS TUMORS.—Swellings of this kind are sometimes seen on the surface of the auricle, particularly in the concha, where the sebaceous follicles are most numerous. They are produced by a closure of one or more excretory ducts, and need only to be punctured and squeezed out.

FRIBROID TUMORS.—These are rare and develop in the lobule as a result of badly managed or badly treated puncture preparatory to wearing ear-rings. Poisonous or irritating substances are sometimes introduced to keep the puncture open. These excite inflammation and swelling, which sooner or later changes into a hard fibroid mass. Only a few weeks since, I saw a little boy, whose father had punctured his ears and introduced course threads. These had already excited considerable inflammatory swellings on posterior surface of each lobule. But, as he had heard that it was *good* for *sore* *eyes*, which his child had, he would not listen to any suggestions in regard to the matter. Fibroid tumors will probably be the result.

TREATMENT.—Excision with scissors or knife is the only treatment. The edges of the wound must be nicely coapted, as in simple incised wounds of the auricle.

CANCERS.—Fortunately the auricle is rarely the seat of cancerous growths. I have only seen one case, which was *epithelial* in character. It was situated in outer end of meatus, and involved a large portion of the concha. When they do occur in the auricle the TREATMENT is the same as for cancers in other parts of the body. The only remedy is excision or destruction by some of the various caustics.

DEFORMITIES.—The auricle may be deformed by injury, and may sometimes be remedied somewhat by a plastic operation, but this is rarely *practicable*.

CONGENITAL DEFORMITIES of the auricle are not uncommon. Sometimes only a small tubercle, a very rudimentary auricle, is present. Other times only a small portion of the auricle is absent. Between these two extremes there is almost an infinite number of varieties. Usually there is more or less deformity or contraction of the external meatus and even of the deeper-seated parts of the ear. The apparent cause of these deformities seems to be a defective development of the part.

TREATMENT.—This can only be surgical, and in the very *fewest* cases is surgical interference advisable. The almost promiscuous cutting done in such cases by general surgeons is not by any means justified by the results. The external meatus, the drum, and even the labyrinth are so often defective at the same time the auricle is deformed, an operation is indicated only in a case of rarest exception. The skin is often unbroken where the mouth of the meatus ought to be; or there may be a small opening large enough to admit a small probe. The only object of an operation is to open up the closed meatus and thus restore the hearing. It is only where there is *positive* evidence of the soundness of the deeper-seated parts that it is to be undertaken at all. Then again, if it is possible to open up an artificial passage down to the drum, it is a very difficult matter to keep it open by the introduction of foreign substances into the incision. The rule is that it will close up again in spite of the efforts and ingenuity of the surgeon.

I have never advised an operation in any case I have seen. In fact, I am strongly disposed to advise against operative interference. There may be cases where circumstances would justify it.

So far as restoring the deformed auricle is concerned, that is out of the question. Sometimes the entire auricle is wanting. In such a case an artificial auricle might be worn.

Gouty Auricle.—Gouty inflammation of the upper part of auricle is mentioned by some. It is very rare, and occurs only in persons of gouty diathesis. Such persons should be treated accordingly in a general way.

Frozen Auricles.—Frozen ears are not uncommon in this country. Some months ago I saw several cases on the prairies of the West. Only a few weeks since I treated a man with *blue* auricles, the result of frost-bite some years since. It is not difficult to recognize frozen ears.

Treatment.—When seen in the early stage, before reaction has taken place, this should be brought on as slowly as possible. This is best done by rubbing the ears in a cold room (never in a hot place) with snow or pounded ice, not *violently* but *gently*. This should be kept up till reaction has fully set in. In this way greater or less destruction of the auricle may be prevented.

After the inflammation has set in, to relieve the burning and smarting, a weak solution of carbolic acid (5 to 10 grs. to ounce of water) and a strong solution of morphine (6 to 8 grs. to ounce of water) may be brushed over the inflamed surface several times a day. These may be used separately or in combination.

But the best treatment for frozen flesh I have ever used is common white lead taken from the kegs as found in the stores. This can be rubbed on the parts with knife or spatula. It soon dries and forms a nice protection against the irritation of the air, and besides it seems to have a peculiarly soothing effect upon the denuded skin, which heals up rapidly under its use.

ERYSIPELAS.—The auricle is often the seat of erysipelatous inflammation, but generally erysipelas of the head or face is the primary disease. Sometimes traumatic erysipelas occurs in the auricle. Some years ago I saw a violent case of it at Cincinnati, produced by "*pain paint*," a quack remedy of some notoriety there at the time. The auricle was enormously swollen, but yielded kindly to TREATMENT, which must always be on general principles. No particular local treatment is indicated; lead water and fomentations may be used.

ECZEMA.—This is a form of skin disease that frequently attacks the auricle in all classes and sexes, from infants up to the most aged. Children perhaps are its most frequent subjects. It is modified, but not controlled, by the condition of the general health. The most robust as well as the weakest have it.

The thin delicate skin of the auricle seems particularly adapted to this form of eruptive disease. Eczema of the auricle is not always an independent disease, confined to the ear, but the same eruption frequently appears on other parts of the body at the same time, as on the face and scalp. *Scrofulous* children and adults, who are predisposed to diseases of the bones, mucous membranes, and general skin disease, are more liable to have it than any other *class* of persons. It may attack the whole auricle, or it may appear in one or more small points, as in the angle between the ear and the head, or in some of the deep depressions on its surface. Where the entire auricle is involved, it sometimes swells enormously, and presents the appearance of acute erysipelas, for which it may be mistaken in the early stage; but as soon as the eruption appears its character is easily recognized.

The glands about the ear, in these severe attacks, occasionally inflame and swell considerably, probably the result of the absorption of poisonous material from the diseased ear.

Pathology.—Of the pathology of eczema there is nothing very definitely settled. The disease is called *vesicular*, because vesicles appear on the surface of the skin. Its immediate *cause* is not known.

Diagnosis.—This is easy on account of the peculiar eruption. There is no other eruptive disease of the auricle, except the acute *exanthemata;* and these are always temporary and combined with a general eruption.

The chief symptom of eczema is produced by the formation of a few or numerous vesicles on the surface of the skin, which soon burst and a watery yellowish fluid escapes, spreads over the skin, dries there, and forms crusts or scales. The ruptured vesicles collapse and form scabs over the denuded skin within the vesicle. Beneath this scab an ulcerative process goes on constantly, which sooner or later may penetrate *deep into*, if not *through*, the true skin. When this scab is removed, a depression (an ulcer) is observed, which bleeds easily and quite freely. This bleeding disposition is one of the characteristics of eczema. The slightest irritation produces hemorrhage. The ear of children, who scratch the itching sores, is sometimes covered with blood.

When the whole auricle is covered with the vesicles in the formative stage, there is usually considerable effusion and consequent swelling of the ear. The surrounding glands are also more or less swollen. In such severe attacks there may be some febrile excitement of the general system. This is what is called ordinarily ACUTE ECZEMA. A number of the above-described vesicles may run together and form quite a large sore or fissure in the skin. Acute eczema is always attended with an unpleasant itching and burning sensation, and sometimes with a feeling of fullness from the congestion and swelling.

These acute symptoms sooner or later subside, and the vesicles *dry up*; that is, they burst, discharge their watery contents, collapse and form dry scabs or crusts, the watery secretion having disappeared, so that the surface of the skin is *dry*. If the scabs are removed there is considerable pus beneath them, formed by the ulcerative process above described, with the constant tendency to bleed. The swelling of the auricle has subsided. The febrile excitement is gone. The itching and burning is not so annoying as in the acute form.

This is the condition which may be called

CHRONIC ECZEMA, though it is difficult to say where the acute ends and the chronic begins, as the development and subsidence of the vesicles is not so uniform as this description would seem to indicate.

There are often vesicles in the various stages of development and decay in the same person. The acute eczema will be extending at one point while it is drying up at another.

It is therefore difficult to draw the dividing line between the two forms.

But, from the above description, it will not be difficult to diagnose eczema in general, and then the two conditions, which are called *acute* and *chronic* eczema.

I prefer to give different designations to these two common divisions of eczema. The *acute eczema* I call MOIST ECZEMA, and the *chronic* eczema I call

DRY ECZEMA.—The facts in the progress of the disease will warrant this different designation, and its propriety will appear in the treatment.

PROGNOSIS.—This is favorable. Though tedious, and sometimes very troublesome, eczema of the ear will get well by persevering treatment. Most cases are easily relieved. *Troeltsch* and *Gruber* speak of repeated relapses in eczema. This has not been my experience. Skin diseases in general are much more common in Germany than in this country, on account perhaps of the less favorable circumstances of the common people there. This may account for the stubbornness and relapsing disposition observed by these two authors in eczema of the auricle.

The prognosis in poor, complicated conditions of the general health is not so good, but here even it may be called favorable. I have never seen a case that would not get well.

Treatment.—As filth *seems* sometimes to be the exciting cause, *cleanliness* must be insisted upon. All local excitants or irritants must be removed. For instance, if the lobule is affected and the patient is wearing a rough, irritating, or poisonous (as brass) ear-ring, which may be the exciting, as well as aggravating, cause of the eczema, it must be removed. If the patient is using any irritating hair-medicine or face-powders, these must be stopped.

If there is a discharge from the meatus, that runs down over the auricle and corrodes the skin (which is sometimes the exciting cause of eczema), that must be treated.

If the general health is not good, internal treatment must be directed according to general indications.

The internal treatment is very important in persons of scrofulous diathesis, and in persons who have a general tendency to skin disease in other parts of the body. In this latter class arsenic does good service. It *seems* to have something of a specific action on the general skin. *Fowler's solution* perhaps is the best preparation to use. It is best to begin with small doses and increase as the patient will tolerate it.

In scrofulous subjects, quinine and iron, and all that class of remedies, are used, as may be indicated in each individual case. In young people syrup of iodide of iron is the most convenient. In infants, internal medication is not advisable.

In the local medication of auricular eczema, one thing is of vital importance; and that is, that, whatever medicines may be used, they must be brought into *direct contact* with the diseased surface, with the sores of the skin. This can not be insisted upon too much. Before each application the mass of secretions, that cover the denuded skin, must be carefully removed. If warm water will not cleanse the parts, it is advisable to apply a soft poultice for about half an hour preparatory to treatment. This will soften the crusts and scabs so they will come off easily. The only object of the poultice is to soften and loosen the scales, and it should never remain on the ear till it dries and gets stiff. Then it is a source of irritation. After the poultice is removed the parts should be immediately cleansed with a soft rag (and warm water, if necessary) as nicely as possible. A sponge is not to be used, as it is too rough. In some places the secretion will stick too close to be removed without violence. Such points had better remain. They will soon loosen. Violence to the tender skin should be avoided, and as little bleeding as possible from its surface caused. Having thus cleansed the parts well, what is the best treatment?

MOIST ECZEMA.—In this form my custom is to use a strong solution of nitrate of silver (10 to 20 grs. to ounce); or, instead of this, compound nitrate of silver may be used, but in double the strength. (Argent. nit. comp. is composed of equal parts of silver and potash.)

This I brush on the cleansed surface with a camel's hair brush, and take special pains to get it to come in contact with all the points of denuded skin.

If there are any places where the crusts or secretions are still adhered, the solution should be applied to them also. It will probably loosen them by the next day. The application should be made once a day. It will smart a little at first, but that will soon pass off. In the meantime the patient should be directed to keep out of strong wind, and let his ear be uncovered. He should not tie it up. I know that this is in opposition to the generally received opinion on this point in the treatment; but I consider that the rags, or whatever may be used, in contact with the *raw* skin, do more injury than good. Then it seems to me that the fresh air has a *favorable* rather than an injurious effect upon the ear.

The hair must not be allowed to adhere to the raw surface. It is not always necessary to use the poultice preparatory to the treatment, but only when the ear can not be well cleansed without it. The only object in its use is, as already stated, to soften the thick mass of crusts and secretions, so they can be removed without violence to the parts.

Under the treatment the raw surfaces secrete less and less fluids from day to day. A few days are usually sufficient to convert the *moist* into *dry* eczema, when the treatment should be changed to suit

DRY ECZEMA, which requires particularly *oleaginous* applications, the caustic treatment being contra-indicated. Any of the oils do good service in the dry form of eczema. The following may be referred to particularly as being the best, to wit: *Cod-liver oil*, *benzoated oxide of zinc ointment*, and *brown citrine ointment.*[*]

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[*] This ointment is not officinal. It is the same as common citrine ointment, except cod-liver oil is used instead of neat's-foot oil. Dr. E. Williams, of Cincinnati, took the formula from some of *Wilde's* writings, and introduced it into this country some years ago. Since then he has used it very extensively in both ophthalmology and otology, eczema being one of the diseases for which he uses it. Druggists say it is somewhat difficult to make. *Hoelke Bros.*, of this city; A. Fennel, and Dr. Wayne, of Cincinnati,

The parts must be well cleansed, so the oils and ointments can be brought into direct contact with the sores. In doing this as little violence as possible should be done, as that always aggravates the trouble. The bleeding is to be avoided also.

The oils or ointments must be applied two or three times a day and the parts should be constantly saturated with it, so as not to allow the reformation of the scabs. Here the ear should also be left uncovered.

If, in the same person, there is a mixture of *moist* and *dry* eczema, as not unfrequently occurs, the moist spots should be cleansed and cauterized, as recommended in the *moist form*, and then the ointments applied over the whole.

This course of treatment is to be continued till the eczema heals up. Most cases get well in from two to three weeks.

As to choice of remedies, the zinc ointment is well known as a good remedy in eczema.

Cod-liver oil is specially desirable for use in children. Any other oils would likewise do well used in the same way.

But of all the oils and ointments, I prefer the brown citrine ointment (unguentum citrinum rubrum) to the almost total exclusion of all the rest.

It is particularly indicated, not only in *dry eczema*, but in all *dry* skin affections. It does not act so favorably where there is considerable fluid secreted, though even here it may be used to good advantage. Wherever a mercurial ointment is needed, this may be relied

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make it. It is important to have it correctly made. Its virtue, probably, results from the combined action of the cod-liver oil and mercury.

upon. Its good effect is probably attributable to the combination of the cod-liver oil and mercury.

The propriety of dividing eczema into moist and dry, instead of acute and chronic eczema, is seen from the different kind of treatment that is appropriate to each. In the moist (acute), caustics and astringents are indicated; while in the dry (chronic), oils and ointments should be used. Instead of the nitrate of silver in the moist, the various astringents in moderate strength often act well; also carbolic acid solution (5 to 15 grs. to ounce of water).

The silver treatment I consider the *best*. Instead of the poultice to soften the crusts and secretions, any emollient applications may be made. They should, however, be applied freely and remain only long enough to have the desired effect.

In children the silver solution should be weaker than in adults (5 to 10 grs. to ounce). Their tender skins should not be cauterized too severely. In this class of cases astringents act favorably.

It is important, and at the same time difficult, to keep children from scratching and rubbing their ears. *Gruber* recommends glycerine very highly in eczema of children, and relies mainly upon it. I do not like it so well, because it smarts quite sharply when first applied to the raw surfaces. Cod-liver oil will act just as well, *if not better*, and does not smart at all. Neither does the brown citrine ointment, nor the zinc ointment.

Where there are deep fissures in the angle between the auricle and the head, the ear should never be drawn away from the head in cleansing the parts. This always tears the bottom of the fissures, causes considerable bleeding, and seriously aggravates the trouble.

BLISTERS BEHIND THE EAR should be avoided in children under all circumstances. After the blister draws, the child, in rolling its head, presses the auricle down upon it with force enough to burst the vesicles. Their contents, saturated with the blistering material, spread over the auricle, and soon its whole posterior, and even anterior, surface is completely covered with blisters. The child scratches these open; they bleed freely; soon the whole auricle is covered with blood, which may run down on the clothing and into the hair.

I have experienced two or three such "*bloody scenes*" with anything but *benedictions* from the mother. *Now*, I avoid blisters behind the ears in children.

MEATUS AUDITORIUS EXTERNUS.

ANATOMY.—The auditory canal leads from the concha of the auricle down to the membrana tympani. Its length is about one inch. Its upper wall is shorter than the lower on account of the oblique position of the membrane of the drum across the bottom. Its direction is inward, downward, and a little forward. The outer third of the canal is composed of cartilage; the inner two-thirds are bony, the cartilage of the auricle forming the cartilaginous portion and the temporal bone the bony part. The cartilaginous part is attached to the rough margin of the bony part by means of strong ligamentous tissue. The point of attachment is called the *processus auditorius*. There is a deficiency of cartilage in the cartilaginous portion upward and backward. These places are filled up with fibrous tissue.

The canal is not straight, but slightly bent upon itself; the convexity, looking upward, being greatest at the junction of the cartilaginous with the bony part (see Fig. 3.)

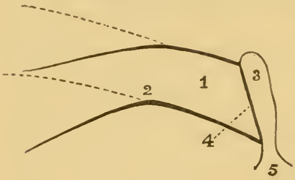

Fig. 3.

The upper wall is curved upward only slightly, sometimes it is even straight. The outer and inner parts of lower wall form an obtuse angle with each other, which points upward opposite the curve in the upper wall. It is this angular projection of the lower wall (see Fig. 3) upward, somewhat encroaching upon the calibre of the canal at this point, that makes it more or less difficult to remove foreign bodies when they once get down to the bottom of the meatus. In syringing the ear it is always necessary to draw the auricle upward and backward, so as to straighten the canal as much as possible. Besides this one well-marked curve of the canal, just described, there are often several other smaller deviations from a straight line, and even surfaces in the different walls. These appear in the form of ridges or eminences, projecting more especially from the anterior, and sometimes from the posterior, wall into the calibre of the meatus so far that it is occasionally difficult to get a good view of the membrana tympani lying behind them.

The bottom of the auditory canal is closed up by the membrana tympani, which is stretched across it in an oblique direction, making the walls of different lengths. The bony part of the canal is lined by the usual periosteum and the cartilaginous part by perichondrium; the two form a continuous membrane at the

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Fig. 3.—1. External meatus; 2. Angular projection of lower wall; 3. Tympanic cavity; 4. Membrana tympani; 5. Eustachian tube. The dotted lines show the position of the straightened walls in syringing the ear.

point of junction of the cartilaginous with the bony meatus.

The skin of the auricle dips down into the external meatus and forms a second complete lining for the canal. Between the skin and periosteum is found more or less connective tissue with hair follicles and wax glands. The two approach each other very closely at the bottom of the meatus. In fact, some writers intimate that they become one and the same tissue near the membrane.

The hair follicles are confined to the outer half of the tube. The wax glands extend down very near to the membrana tympani. The hair follicles and wax glands are situated beneath the skin in the connective tissue (see Fig. 4). The hairs are confined to the outer half, while the wax is poured out upon the entire surface of the canal for lubricating purposes.

In some the hairs in the ear are very numerous, while in others there are almost none at all. These hairs are supposed to prevent the ingress of insects.

The skin, as it enters the external meatus, becomes tenderer and thinner and grows more so as it approaches the bottom. Only the epithelial portion is reflected over the membrane. Its color also changes, but it retains the characteristics of the general skin, and is therefore to be regarded as skin.

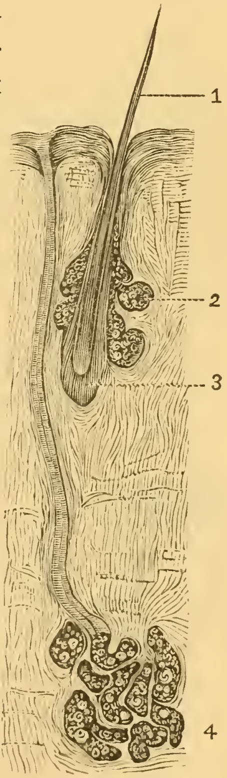

Fig. 4.

Fig 4—Hair follicle and wax gland. 1. Hair; 2. Oil gland for hair; 3. Hair follicle; 4. Wax gland.

Blood Supply.—Its chief supply of blood is obtained from the arteria auricularis profunda, a branch from the internal maxillary artery, which penetrates the anterior wall, and is distributed to the soft parts of the meatus and membrane.

Nerves.—These are principally derived from the *inferior maxillary nerve.* Hence pain in the external meatus may and sometimes does cause pain in the teeth. The reverse may also occur.

Examination of Meatus Auditorius Externus.

In order to see well down into the auditory canal it is necessary to straighten the passage as nearly as possible. To do this the auricle, as already stated, must be pulled upward and backward firmly, so as to bring the cartilaginous portion into a line with the bony portion of the meatus. Holding the auricle in this position and at the same time pulling the tragus forward from over the entrance to the canal, if we look in, we may be able to see down pretty well, if the passage is clear; but most probably we will find the view is obstructed by hairs, by little lumps of wax, and by epithelial scales. An instrument is necessary to press these things out of the way and make the passage clear. For this purpose the

Aural Speculum is used (see Fig. 5). It takes three of these to make a set. They are of different sizes, so as to suit all-sized canals. The medium one most nearly answers for all cases. I use the speculum

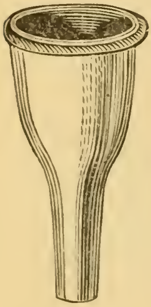
Fig. 5.

Fig. 5.—Aural Speculum.

figured here, which is known as Gruber's speculum, made of German silver and is round. I think this the best of all the numerous varieties. In introducing the speculum, the meatus should be straightened in the usual way, and then the instrument worked, *very gently*, down into the ear till it fits closely in the orifice of the canal, whose walls will usually hold it in position. If not, it must be held in with the fingers. *Now*, the meatus is ready for inspection. But in order to do this it must be illuminated. Formerly the custom was, and still is, with some operators, to let the *direct sunlight* fall into the ear through the speculum. This will illuminate the parts sufficiently to make a satisfactory general examination. But the great difficulty here is that the surgeon, in order to see, has to place his head between the *source* of light and the object to be inspected, and it is very difficult for him to make a satisfactory examination of all the deep-seated parts, and at the same time keep his head out of his own light. In fact, in this method of examination, it is almost necessary for a man to "stand in his own light." Then, again, the sun is not always at command. Sometimes it is *cloudy* and at other times *smoky* or *foggy*. At night, too, an examination would be impossible for want of sunlight. For these several good reasons this method has been almost entirely abandoned for a better one that is always to be relied upon. This *new method*, popularized by Troeltsch, is called

ILLUMINATION BY REFLECTION, than which, it seems, nothing better is to be desired or expected. Its introduction has given a fresh impetus to the progress of otology everywhere. For illuminating purposes in examination by this method the light from any source is used ; as *sunlight*, *daylight*, *gas*, or *lamp light*. While all these give a satisfactory illumination, common daylight, as it comes in through an ordinary window, of rather small size, that looks out, not against another building, but into free space, is to be preferred, as it gives the most natural color to the parts in the ear. When direct sunlight is concentrated upon the ear, it always produces a feeling of warmth, and, if care is not exercised, may produce a serious burn. Gas or lamp light is to be used when it is desirable to make examinations after night. The window from which the light comes should not be too large—four feet square is large enough. If it comes down close to the floor, it is best to shut up the lower part by shutters or thick blind. The light should come from a point considerably higher than the patient's head. If there are two windows in the same side of the room, one should be closed, as there would be a double reflection from two, and that always causes confusion and imperfect illumination.

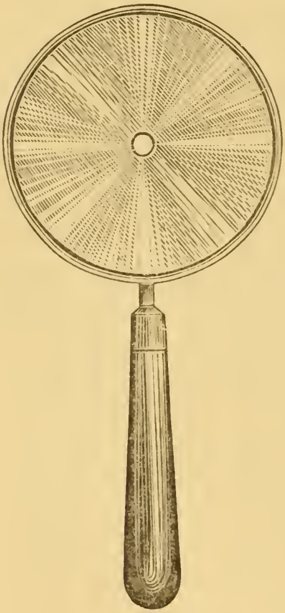

Fig. 6.

The patient should sit several feet in front of the window, with the ear to be examined turned away from and his head inclined toward it and forward. The operator stands on the opposite side of the patient from the window.

In order to reflect the light into the ear a reflector or mirror (see Fig. 6) is necessary. This mirror is concave, so as to concentrate the light, and has a six-inch focus and is three inches in diameter. In its centre is a

Fig. 6.—Mirror (reflector); half size.

small hole through which the operator looks in the same direction in which the light is reflected. With this mirror the light from the window is reflected through the speculum into the auditory canal, and beautifully illuminates its entire extent.

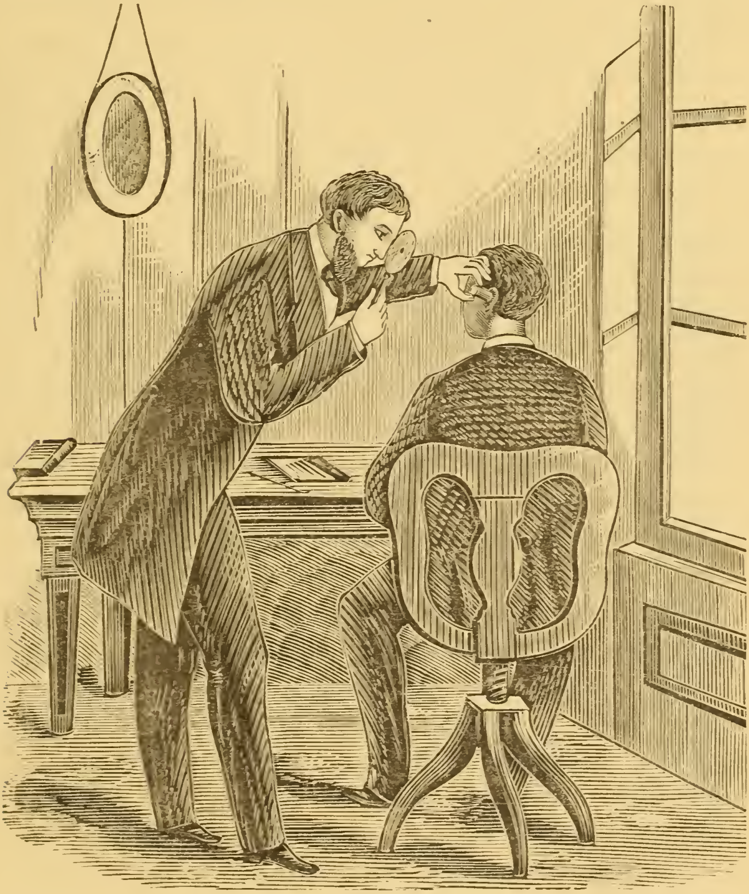

Fig. 7.

In order to see, of course the operator must place his eye behind the mirror and look through the hole in its centre, and bring his head, with the mirror, down

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Fig. 7.—Method of examination.

close enough to the patient's ear to give him distinct views of all the parts of the external meatus and of the membrana tympani (to be considered hereafter). With one hand the speculum must be turned in different directions, so as to bring the different parts of the walls of the meatus and membrane into view.

In this way the minutest examination of all the external parts of the ear, both in health and disease, can be easily and satisfactorily made at all times of day or night, and consequently this method supersedes at once all other methods, both in perfection and convenience, and is therefore to be *exclusively* recommended. A general idea of this method of examination is readily obtained from the accompanying cut (see Fig. 7). In introducing the speculum and manipulating with it *gentleness* must always be the *rule*, so as not to cause *unnecessary* pain.

How to syringe the Ear.—Cold water should never be used in syringing the ear, as it causes considerable irritation and sometimes actual inflammation. I use, and advise others to use, simply *warm water* without soap or anything else in it. These foreign substances in the water can do no good and are more or less irritating.

The water is put into a cup of any kind (an ordinary mug is the best), which is held by the patient (by the mother or nurse in children) close against the neck under the ear, and should not be pressed too hard upward against the meatus, as it may compress its walls and prevent the easy entrance of the water. A towel may be thrown over the patient's shoulder to keep his clothing from getting wet. With the left hand the operator draws the auricle upward and backward, so as to straighten the meatus; with the right hand the water is thrown into the ear with a syringe with considerable force, so that the stream may reach the bottom with sufficient force to produce a sharp counter-stream. It is not easy to use force enough with an ordinary syringe to injure the ear; still, excessive force is to be avoided. The water as it returns falls into the cup under the ear, so that it is not necessary for a single drop to get on the patient. The injection of water is to be thus continued until the object of the syringing is attained. When the water is first injected into the ear it should be done very *gently* and *slowly*, so as not to *frighten* the patient. The syringe (see Fig. 8) I use is known in the drug-stores as "*hard rubber ear syringe*." It is light, has a capacity of about two ounces, which is large enough; and answers the purpose admirably—in fact, better than any other syringe I have ever seen. The large, heavy metallic syringes, recommended by the German authors, are decidedly objectionable on account of their size and weight. So also is the *ear douche* used by *Clarke*, of Boston.

The small, hard rubber ear syringe I recommend, can be used easily with one hand, which is a decided advantage, and sufficient force for all purposes can be produced with it.

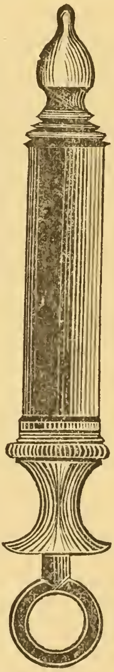
Fig. 8.

THE NERVOUS IMPRESSION caused in syringing the ear is not uniform. Some are not affected at all; others get quite *dizzy* and reel about when they get up from the chair as if intoxicated, and have

Fig. 8.—Hard rubber ear syringe (half size).

to sit down again to keep from falling. Others are still more seriously affected.

I have seen stout hearty men tumble down during or after the syringing. I have seen both men and women vomit freely after syringing the ears. The so-called *nervous* are not more affected than the opposite class. The results are never serious. The nervous impression passes off in a very few minutes. The dizziness probably results from indirect pressure upon the brain from the weight and force of the water upon the membrane. The nausea is most likely the result of irritation of the nerve filiment from the *par vagum* distributed to the meatus. It is the irritation of this nerve that causes spasmodic coughing when the skin is irritated by introducing the speculum or instruments into the ear, as stated above.

WHY IS THE EAR SYRINGED?—There is only one indication for syringing the ear, and that is for the single purpose of *cleansing* it. When there is nothing in the ear that should come out, there is no object in syringing it. It does not do to *guess* there is something in there; but it is the *duty* of every *aural surgeon* to *know*, by actual inspection, that something is in there before he undertakes the syringing process. The almost promiscuous use of the syringe, so common among physicians, is not only inexcusable, but actually injurious. Then, may it be remembered: *The ear is to be syringed only when there is something in there to wash out.*

WAX IN THE EARS.—The wax follicles or glands of the external meatus, in a physiological condition, must secrete wax. This secretion is going on constantly; so there must be a constant waste of wax from the ears; else there would be an accumulation in everybody's ear, which is not the case. The wax is constantly evaporating (the watery portion at least) from the ear; it escapes by running out at night often, and even in daytime it is visible in the ears of some. It is picked out with the finger, with pins, with scoops, and in washing and wiping the ear. So that, in a healthy condition, there is a pretty large waste of wax from the ear. In a physiological or healthy condition the supply and waste are equal. But suppose there is, from some cause, a reduction of the amount of natural secretion, there will be very soon a change in the condition of the meatus, as indicated by the general

DRYNESS, which implies a want of wax in the ear. This change actually takes place in the auditory canal in consequence of, or from sympathy with, diseases in the deeper-seated parts, as in catarrhal inflammation of the drum (to be referred to hereafter). This dry condition may be induced artificially by unwise irritation of the skin of the meatus.

The secretion of wax may be partially or totally suppressed by frequently syringing the ear; particularly when cold water is used. Dropping cold water, or glycerine, or any of the various oils, or putting fluids of any kind repeatedly into the ear, excites a kind of chronic inflammation in the skin that materially interferes with the physiological action of the wax glands. In this way it is easy enough to account for the *dryness* of the ear, but it is not so easy to explain the cause or causes of the

ACCUMULATION OF CERUMEN in the external meatus.

If, from any cause, the natural waste of wax from the ear is interrupted, accumulation necessarily follows. This is the evident cause, in an occasional case, as where the hairs, particularly in old people, or where narrowing of the orifice of the meatus, reduce the amount of evaporation, and thus prevent the escape of the wax from the ear in the usual quantity.

Then there is such a thing as *hypersecretion* of wax—where there is more wax formed than is natural, and consequently an accumulation in the ear. Cases are not unfrequent in which the meatus is refilled with fresh wax in a very few weeks after it has been thoroughly washed out. In the same individual this may occur again and again, necessitating repeated syringing of one or both ears. This must be a *hypersecretion*, as nothing of the kind takes place normally. But this unnatural secretion must have a cause, and, in my judgment, that cause is to be found in a *diseased condition* of the skin and the glands themselves. Upon no other hypothesis can the frequent accumulation of wax in the ears be satisfactorily accounted for. It frequently takes place only in one ear. If it was due to some *external influence* both ears probably would be similarly affected.

Foreign substances in the ear, as a lump of cotton or piece of paper, often form evident nuclei for the wax accumulation. It is easy to suppose that these foreign substances produce an irritation, and that in turn causes the hypersecretion and consequent collection around the foreign bodies.

These plugs of cerumen are nearly always composed of epithelial scales, loose hairs, and wax, showing that the epithelium and hair follicles, and, by *implication* at least, the wax glands are diseased. By reason of this diseased condition of the parts, the nature of the secretion is changed; the wax becomes *thicker* and *tougher*, and consequently *less* disposed to evaporate, and of course a greater tendency to accumulate is the result.

This, I think, is the *true* explanation of the frequent collections of wax in the ears.

Gruber expresses his belief that a diseased condition of the *glands* lies at the bottom of the whole affair.

Diagnosis.—This is very easy. It is only necessary to look into the ear to discover the plugs of wax. In appearance they differ according to their age. When recent or fresh, they are soft and have a light brown color. When old, they are hard and have usually a dark or black color. Sometimes, however, the surface *glistens*, from the presence of cholesterine. The *subjective* symptoms are not uniform; the chief complaint is the *deafness*, more or less complete, according to the size of the wax plug. If it stops up the meatus completely and tightly, there will be almost total deafness. This may come on suddenly, as where, from any cause, the plug is moved, so as to suddenly close up the ear. Picking, pulling, or rubbing the ear, shaking the head, stooping or lying down or moving the jaws, may bring on the sudden deafness by moving the wax plug. Persons often say that putting water or oils into the ears makes their hearing worse. These cause the wax to swell, and of course increase the deafness.

Great dizziness, simulating brain trouble, may suddenly come on. In moving, the plug of wax falls against and presses upon the membrane. This produces pressure through the chain of little bones upon the fluids of the labyrinth, which is about the same as pressing directly upon the brain. Hence the sudden dizziness.

Troeltsch reports an interesting case of *apparent* brain trouble following an injury.

An old man fell down and struck his head against the pavement. Serious brain symptoms set in at once.

His physician, naturally enough, diagnosed injury of brain, and treated him accordingly, with very little success. After a time Dr. *Troeltsch* was called in on account of the deafness; he found and removed a large hard mass of cerumen from his ear. Suddenly the brain symptoms disappeared, the deafness was cured, and the man was well! The explanation is that, in the fall, the wax moved so as to close the meatus and produce the deafness, and at the same time pressed upon the membrane, causing the brain symptoms. This only shows the importance of *thorough examination* in all cases.

Noises in the ear are frequently complained of. These are light or severe, according to the amount of pressure upon the membrane by the mass of wax.

Prognosis is favorable as a rule. If the condition of the deep-seated parts of the ear could be known, whether they are healthy or not, then the prognosis would be accordingly favorable or unfavorable. Some ears that are seriously diseased in their interior, may have accumulations of wax in them. Of course the removal of the wax would not cure the deep-seated trouble.

So the prognosis must be at least *guarded*, till the cerumen is cleared away and an examination made. If let alone, these masses of wax would remain harmless in the ear for an *indefinite* time, except perhaps in occasional cases where they press upon the membrane sufficiently to excite cerebral symptoms. Occasionally attacks of inflammation are observed in connection with the collections of wax, producing a watery or purulent discharge.

Some writers say they have known these accumulations of wax to cause, not only ulceration of the soft parts, but even the bone substance has been invaded.

Gruber expresses the opinion that in such cases dark-colored tumors (cholesteatoma) developing from the interior, and appearing externally, have been mistaken for collections of wax.

I have never seen any serious injury from collections that have remained in the ear for years and years, except the deafness.

PATHOLOGY.—From the foregoing remarks, it will be inferred that a *diseased condition* of the skin and wax follicles or glands is the direct cause of accumulations of wax in the ears. The nature of the disease is not established, but it produces in some way an *altered hypersecretion* of wax, which, together with the epithelial scales thrown off, and the loose hairs that fall out, form the masses of cerumen.

TREATMENT.—This consists simply in the *removal* of the plugs of wax by syringing the ear with warm water. I never use anything in the water, as foreign substances are more or less irritating, and do not add any virtue to the action of the water. Usually it requires only a few minutes to wash out even the largest plugs from the ear. In syringing, the stream should be directed as closely as possible along the upper wall of the meatus. The wax always *gravitates* down upon the lower wall, and consequently the water can be driven easiest above the wax down to the bottom of the ear. As soon as it strikes the membrane it turns its course, and works its way in between it and the wax, until finally the force of the water dislodges and drives it out. The lumps, particularly when they are large and hard, *very rarely* come clear out into the cup, but nearly always lodge in the outer orifice of the meatus, and can be easily removed with the forceps.

When the wax comes loose from the membrane, it produces a *crack* and some pain ; the patient almost invariably jumps and complains of pain. *Now*, if the operator will look into the ear, he will find the plug sticking in the end of the meatus.

Occasionally a plug of wax sticks so *tightly* to the bottom of the ear that the syringing process has to be continued for some time before it comes loose. My custom is to *persevere* till I succeed. It rarely requires more than ten minutes, usually less time than that. But I remember one case where it took me at least an hour to get the ear clean. The lump was *very large* and *very hard*, and was *tightly wedged* in the bottom of the meatus, and lay *flat* on the membrane. In order to loosen it I had to pass a probe down between the wax and upper wall of meatus and turn it outward, using the mirror at the same time so I could see where the probe was going and what I was doing. (These manipulations in the ear should *never* be made without the mirror.) I succeeded very easily in loosening it, and then the water brought it out without trouble.

I have used the probe in this way several times with good success, and never caused the patients any trouble or pain whatever. It is certainly better to do that than to continue the syringing too long.

The custom, so common among general physicians as well as specialists, of putting water or oils into the ears of patients to soften wax before they undertake to remove it, is, as it seems to me, a bad one, as they can not rely upon their return, and consequently they may get the *credit* of making their ears worse.

Whenever oil or water is poured upon inspissated cerumen it swells considerably, and of course increases all the subjective symptoms.

For this reason I never do it, but prefer to remove the wax without delay. After its removal, if the ear is well dried with the towel, it is not necessary to put cotton into the meatus to prevent trouble, though the patient may do so if he wishes, but it should not stay there more than a few hours.

If the deeper parts of the ear are sound, the subjective symptoms will all subside as soon as the wax is removed, and the hearing will return immediately. If it does not, it is evident that there is a deeper-seated trouble; probably in the membrane or drum, which must be sought out and remedied if possible. (See Diseases of Membrane and Drum.)

FOREIGN BODIES IN THE EXTERNAL MEATUS.—Anybody may get foreign bodies into the ear, but children and young persons are chiefly the subjects of this kind of trouble. In a playful way they stick all kinds of things into their own ears or into the ears of each other. Beans, peas, bullets, pins, bread-crumbs, slate-pencils, pebbles, beads, buttons, and grains of corn are the most common things found in the ear. *Insects* occasionally crawl into the ears of either children or grown persons while asleep. In fact, any small insect of rapid locomotion may run into the ear before its progress can be checked. So, in general terms, it is easy to get things into the ear, but not always so easy to get them out.

DIAGNOSIS.—It will never do to rely upon what the patient says about there being something in the ear; he may be mistaken. I have seen such cases. It is the *duty* of every physician to examine and see for himself before he undertakes to remove it. It is a very easy matter to see any foreign substance in the meatus. If any small body has been pressed through the membrane into the tympanum, it may not be so easy to discover it.

The *subjective* symptoms are usually very slight. In fact, many persons carry foreign substances in their ears for months, and even years, without knowing it, and are much surprised to find it out.

Then, again, others may have a great deal of trouble from them. This depends upon the irritability of the individual, and upon the nature of the foreign body. The mere idea of something being in the ear will often throw nervous persons almost into spasms. Then, if the foreign substance is something that will burn or act chemically upon the soft parts, or if it has sharp edges or corners, or if it is something of a poisonous nature, it may cause not only pain, but severe suffering. Cases are reported where the irritation in the ear caused spasms, paralysis, and other sympathetic nervous troubles, as *epilepsy*, *paralysis of one arm*, and *anæsthesia* of half of the body, as reported by *Toynbee*; all of which was relieved by the removal of a glass ball from one ear that had been there for eight years.

Wilde reports a case of epilepsy and deafness cured by removing a foreign body from the ear.

I saw a man some years ago who had become a *monomaniac* over the idea that an insect had gotten into his ear and worked its way thence into the brain. The membrane, upon examination, was clear and unbroken and evidently healthy; but no amount of persuasion or argument would convince the man that there was no *bug* in his brain. He *knew* there was, for he could feel it *squirming* and *kicking* in there.

When foreign substances get into the cavity of the drum (see Diseases of Drum), life is even endangered. Deaths are reported from that cause.

But all these *grave* symptoms, following the introduction of bodies into the ear, are observed only in *exceptional* cases, which are fortunately rare. The fact, however, that they do occur from such causes, should teach physicians to look into the ears of their patients much oftener than they are in the habit of doing.

When foreign bodies press upon the membrane (see Membrana Tympani) they may cause noises in the ear, and even brain symptoms, the same as plugs of wax. If an *insect* gets into the ear and begins to run about over the surface of the membrane, it causes *fearful noises—a regular storm*—in the ear, which will soon make a person *frantic* if not stopped. In such an emergency it is only necessary to fill the ear full of water and make the thing run out to save its life, or drown it, and then remove its *carcass* as other foreign substances.

But the surgeon must, after all, *rely* upon what he *sees* in his examination; and, *when* he *sees* a foreign body in the ear, he *knows* it is there, and his diagnosis must be correct.

I have given the above serious subjective symptoms somewhat in detail, to show the *possible*, *very ugly symptoms* that may be excited by the presence of a foreign body in the external meatus.

PROGNOSIS.—This is very favorable, except where the foreign body gets into the drum cavity and it can not be removed. In that case the result *may* be fatal, though not necessarily so. Of course, as soon as the foreign substances are removed, the symptoms will all subside.

THEIR REMOVAL is easy, if rightly gotten at, and *very difficult*, if undertaken in an improper way. *No violence* is the first rule. That should never be forgotten. Patients, under such circumstances, get greatly excited; the doctor catches the excitement often and fails to do what he wants to do, and does many things he should not do. It is rarely ever necessary to cause the escape even of a single drop of blood, *much less profuse hemorrhage*, by the manipulations. It is proper to say here again that the foreign body must be *seen* before its removal is attempted. The surgeon must never *suppose* it is there and begin to *fish* for it in the dark. Having discovered it, the proper procedure is about as follows:

If the foreign body is a small hard substance, with no sharp corners or edges, it may fall out of its own weight, if the head is turned far enough to that side to bring the axis of the external meatus into a vertical position, so that the substance, in gravitating downward, will, with respect to the ear, *gravitate* directly *outward*. In this way it may be made to *fall* out. If that does not succeed (its success or failure can usually be foretold from the nature of the body), then syringe the ear with warm water with considerable force. If the foreign body is not *tight* in the bottom of the ear, it will be washed out by the force of the recurrent stream. The syringing process should not be continued long; if it does not succeed in a few minutes, it will not at all and might do harm.

This having failed, take a large-sized speculum and introduce it into the ear as far as possible without producing pain, and with the mirror look in. The foreign body will be found *wedged* in at the bottom *too tight* for the water to start it. If a bean or pea, it has probably swelled till it fills up the bottom of the meatus tightly and completely. This condition of things I have seen a number of times. Take a long slender pair of toothed forceps (I usually use Graefe's common fixation forceps, which would be still better if they were still slenderer), and pass them through the speculum down to the foreign body, and gently work the branches in on opposite sides, and thus grasp and gently draw it out. If the forceps slip off or the hold breaks off, as it may do in soft substances, replace the forceps and renew the hold as before, and continue the effort till it is successful. Forceps with teeth hold better, of course, than smooth ones. If the foreign body is too large to pass through the speculum, let that slip out before the foreign substance as it is brought out. The mirror must always be used in making these manipulations, so the operator can see distinctly where his forceps are going and what he is getting hold of. If a flat surface of the foreign body presents so it is impossible to get hold of it with the forceps, then take a common stiff probe and pass one end down between the upper wall of the meatus and foreign body, and turn one or the other end or edge outward, so the forceps can be made to take hold of it, and extract as before. I have found the use of the probe in this way necessary in one or two cases I have seen, and succeeded without any trouble or pain to the patient.

Instead of using the forceps after the foreign body has been turned so as to loosen it, the syringe might be tried again. That would very likely bring it out. There is no objection, however, to the use of the forceps or any other instrument that may be necessary, if they are *properly* used. Formerly nearly every surgeon had his instruments expressly for the removal of foreign bodies from the ear, and used nothing else. No other part of the body has ever suffered so *fearfully* at the hands of the surgeons, physicians, and the common people. It makes me shudder when I think of the *extreme* violence I have seen inflicted upon the ear in fruitless efforts to remove foreign bodies from it. This, too, was the work of persons high in authority in general surgery. In consequence of all this unnecessary violence done with instruments, our best authorities in otology are now disposed to go to the other extreme of "*no instruments*" in removing foreign substances from the auditory canal; rather let them stay there, they say, than to use instruments in their removal. This is going a little too far the other way. Instruments are not *dangerous* when handled rightly. All foreign bodies in the ear should be removed as soon as possible. It is impossible to syringe them all out, as we have seen already. In such cases I use instruments, and it is every surgeon's duty to use them when necessary. One thing, however, is to be remembered—*do no violence with them.* As already stated, it is rarely necessary to cause even a few drops of blood to escape. Where, however, a little does escape, it must be syringed out so as not to obstruct the sight. If pus is in the way, that must be washed out also. In the use of instruments one precaution is always to be strictly observed, and that is, never to press the foreign substance against the membrane. That might do serious injury.

When instruments, other than the syringe, have to be used in children, it is always advisable to give chloroform, and not try to hold them with main force. Sometimes chloroform has to be used with grown people.

If the meatus is swollen, inflamed, and painful, from former efforts at the removal of the foreign body, then it is best, and in fact advisable, to wait till the swelling and soreness subside, and then remove it.

Sometimes, before the patient comes under the care of a physician, his friends, in their vain and always useless efforts to remove the foreign body, have pressed it through the membrane into the cavity of the drum. If small or flat, it may have slipped down into that cavity out of sight, or it may be lodged against the opposite wall of the tympanum. I have seen two or three cases of this kind. The bodies being too large to slip clear into the cavity, I had no trouble to remove them in the ordinary way.

If a foreign substance gets into the drum cavity, and it can not be removed by *very cautious* use of instruments and can not be driven back into the meatus by inflation (to be described hereafter), then one of two things must be done: Either let it alone, or remove it by making a serious surgical operation. As long as it is harmless, that is, causing no serious symptoms, it would certainly be best to let it remain there. If, however, at any time it should excite serious brain symptoms and it became a question of life and death with the individual, then operative or surgical interference might be advisable.

Under such circumstances, *Gruber* proposes to enter through the mastoid process and the posterior wall of the meatus, and reach the cavity of the drum from behind. *Troeltsch* prefers to enter through the superior wall. These operations, however, are only to be thought of when there is no other resource and life is in great danger.

Roosa, of New York, says he once brought a foreign body out of the drum into the meatus by continuous use of poultices. I can not understand how it is possible for these to *draw* a foreign substance from the drum into the meatus.

Finally, in all these manipulations in the external meatus, let it be repeated again, that the parts must always be well-illuminated, so that the operator can distinctly see what he is doing and scrupulously avoid tearing or injuring the soft parts.

Some operators use a head-band with a mirror attached (see Fig. 9) for illuminating purposes in these delicate manipulations. I prefer to hold the mirror in my left hand and manipulate with the right, and, if necessary, have an assistant hold the speculum or auricle for me. The head-band does not work well for me; perhaps I have not used it sufficiently.

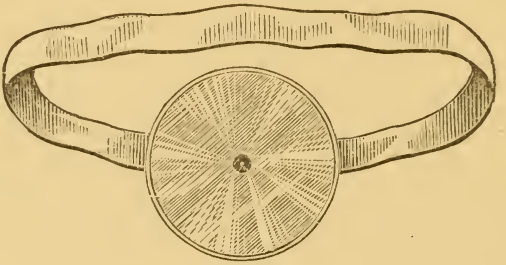

Fig. 9.

Inflammatory Diseases of External Meatus.

Inflammation of the external meatus is technically called *otitis externa*. This may be confined to one or more points in the meatus, and is then called otitis *circumscripta*, commonly called *furuncles* or *boils*; or it may involve the whole canal, and is then called otitis *diffusa*.

Boils in the Ear.—A person, in apparently good health, while in the performance of his ordinary daily work, may have an itching or burning sensation in one of his ears; without thinking, he scratches it with his finger, tooth-pick, or pencil. In a little bit he notices

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Fig. 9.—Head-band, with mirror attached.

that the itching has increased, and again he scratches the ear more violently than the first time, without allaying the irritation.

This constantly increases, and soon gets to be *painful*, and, in a few hours, amounts to *severe suffering*. Soon the pain spreads from the ear to the surrounding parts; to the teeth, to the corresponding side of the head, if not to the whole head, and more or less down the muscles of the neck. Soon every movement of the lower jaw increases the suffering. Pulling or pressing upon or even touching the ear intensifies the pain. The heat of the face and head is considerably increased. Very soon the individual considers himself sick, gives up his work, and sends for his physician in the hope that he may get relief from the severe suffering.

The physician makes an examination, and finds somewhere about the junction of the cartilaginous with the bony meatus a small round elevation, perhaps a little reddened, about the size of a pea or bean, projecting above the general surface toward the opposite side of the canal. If he presses upon it with a probe, the patient jumps and cries, "*You hurt!*" If he presses upon the outside of the ear, corresponding to its location, pain is produced. Otherwise the meatus seems to be healthy. Now, the physician can conclude with certainty; *this* is a *boil*, a *furuncle*, an *abscess* in the ear. Thus suddenly and unexpectedly do these abscesses usually make their appearance. All classes are about equally subject to the disease. In extent and intensity it varies. Sometimes only a small point; at other times a large portion of the meatus is involved. Sometimes there is only one boil; at other times there is a cluster of them. Sometimes there is only slight swelling; at other times the swelling closes up the meatus and interferes with the hearing mechanically. These abscesses are usually located about the junction of the cartilaginous with the bony parts of the meatus; mostly in the posterior, inferior, and anterior walls: I have only seen one boil or abscess in the upper wall. They may develop internal or external to that point, and are accordingly more painful or less painful.

Pressure upon the nerves in consequence of the swelling produces the intense suffering. The pain extends to the surrounding parts in consequence of the intimate nervous connections. The trigeminus sends branches to the meatus; consequently the teeth may become painful, though not always. In fact, it is sometimes difficult for the patient to determine whether the pain is in the teeth or in the ear.

The pneumogastric sends a nerve twig to the auditory canal; hence the stomach may be nauseated by boils in the ear. This symptom, though rare, might lead to the mistaken diagnosis of meningitis. (*Gruber.*)

Noises in the ear occasionally accompany abscesses in the meatus.

THE DIAGNOSIS, in general, is easily made out. The physician must rely mainly upon the objective symptoms, as other diseases produce very similar subjective symptoms. If he finds the characteristic round conical swelling, as above described, which, upon pressure, is decidedly painful and its apex easily indented, which is evidence of fluid beneath the skin, there is no question as to diagnosis. It may be more difficult in the incipient stage or less typical cases to make a satisfactory diagnosis, but usually it is easy enough. The skin covering over the boils has usually the natural color of the skin at other points; it is occasionally slightly reddened, but never presents the fiery redness of boils on other parts of the body. In this respect they resemble common abscesses more than boils.

Exciting Causes.—Patients attribute the whole trouble generally to *bad colds.* Strong cold winds, cold water in the ear, injection of medicated solutions, the common habit of picking the ear with pins, tooth-picks, ear-scoops, sticks, and the like, are numbered among the exciting causes. So far as I know, there is no particular constitutional condition that specially predisposes to the development of abscesses in the meatus. Such an idea is contradicted by the fact that all classes suffer from them about equally.

Prognosis, so far as each individual furuncle is concerned, is very favorable. Each one will get well in a few days even without treatment, but in prognosing the fact must not be forgotten that there is a strong tendency, in many cases, to relapse; not that the old one returns or is reproduced, but that new ones continue to develop, one after another, in different parts of the meatus. While it is easy to cure one, it is very difficult to keep others from forming.

Pathology.—The immediate cause of boils in the ear, as now understood, is a diseased condition of the hair follicles or wax glands: these inflame; the inflammation extends to a small portion of the surrounding tissue, the swelling of which cuts off the supply of nourishment from the follicle or gland; that dies in consequence and forms the centre of the boil—the so-called *core;* the surrounding tissue suppurates and produces the very small amount of matter usually discharged from such an abscess.

Treatment.—Whatever indication there may be for general treatment in each particular case should be met. Whatever is wrong in the general health should be righted, of course. The chief reliance, however, is in the local treatment.

As soon as a satisfactory diagnosis is established, the boil should be freely incised; the earlier the better. It is not advisable to wait till the presence of pus can be detected. The great object is to relieve the intense suffering as speedily as possible. This can only be done by an early and deep incision through the seat of the abscess down to the bone. If pus escapes, so much the better; if there is no pus, it will bleed freely at any rate, which relieves the tension and pressure in the parts, and in a few minutes the severe suffering ceases. The bleeding and suppuration, if there is any, should be promoted by syringing the blood out with warm water, and then keep the ear filled with it for a short time after the incision.

After this the patient should keep out of strong wind, but not stop his ear up, as the foreign substances might cause an injurious irritation in the meatus; then it is better, in my judgment, to let the fresh air into the ear, which produces a cooling effect upon the parts.

If there are several furuncles forming at the same time, as is sometimes the case, and the incision fails to open them all, the relief to the patient will not be complete. As soon as it is possible to discover the unopened ones, they should be incised also.

The manner of the incision must be left to the convenience and judgment of the operator. I usually pass a narrow knife into the meatus beyond the furuncle, and make the incision as I draw it out. Or, the knife may be passed through the base of the boil, from without inward, and then cut out through its apex. The most important part, in opening these abscesses, is to make the incision liberal and deep, and to do this requires more force upon the knife than a person, who had never made the operation, would suppose. The knives usually recommended for this purpose are too slender; they bend under the necessary force and do not cut easily. The knife therefore must be large enough not to bend, and yet small enough to pass into the meatus.

In opening these abscesses the surgeon must not expect to see a stream of matter escape; only a few drops at most will be seen—sometimes only a little white point or two as large as a pin's head: then, again, the blood may cover up what little there is, and none at all be seen.

But some persons have such a horror of the very idea of a knife, that it is impossible to get their consent to have their ears cut. Such cases must be palliated as much as possible until suppuration takes place and the abscesses open of themselves, which will take place in from two to five days. The suppurative process should be promoted by warm applications to the ear; the best of all applications for this purpose is filling the ear repeatedly with warm water. *Troeltsch* is bitterly opposed to the use of poultices in such cases, and *Gruber* objects to steaming the ear.

I am in the habit of directing hop-poultices in such troubles, and find they have decidedly a soothing effect besides the moist heat they contain. In addition, anodyne solutions may be frequently dropped into the ear; such as morphine and atropine solutions, each from three to five grains to ounce of water, in combination or separately. Of the two the atropine is by far the most effectual anodyne, and I always give it the preference. These solutions should be warmed, and may be dropped into the ear every hour till the pain is relieved.

If this local treatment is not sufficient to allay the intense suffering, then opium must be given internally in sufficient quantities to lull the pain and make it tolerable.

Morphine may be used hypodermically about the ear, but always with caution.

During the progress of this treatment the physician should continue to use his *persuasive* powers upon the patient to have the abscess opened and be done with it. The promise of certain relief is the most potent argument that can be used in such cases. The local treatment should be at once discontinued as soon as the furuncle opens and the pain ceases, for fear that the continued moisture and the medicated solutions might start fresh boils.

Preventives.—Oftentimes, as intimated in the general prognosis, when boils once begin to form in the meatus, no one can tell where the end will be; one after another, apparently in regular order, comes and goes. Any man or women with a boil in the ear is incapacitated for business, besides the suffering they have to endure; consequently their prevention becomes a matter of great importance.

It is to be regretted that there is no specific or certain preventive known to the profession. Strong solutions of nitrate of silver, all kinds of oils and ointments, down to goose-grease and rattlesnake-oil, have been tried, recommended, and abandoned as worthless.

Gruber says that where free incisions in the skin of the meatus have been practiced in the treatment of the first boils, their recurrence is much less frequent, and for this reason he highly recommends that kind of treatment in the earliest stage of the trouble. He does not confine his incision to the locality of the boils, but scarifies the meatus in several places on its different walls, and always aims to cut down to the bone.

It seems to me that such extensive scarification causes the patient unnecessary suffering.

I always confine my incisions to the seat of the abscesses. But even after *Gruber's* extensive scarifications, in the very earliest stage repeated abscesses are not uncommon, as he acknowledges himself. So his *heroic* treatment is not at all a sure preventive.

I have more faith in a constant counter-irritation, before or behind the auricle, than in any other treatment. The irritation, however, must be deep, so as to keep up a constant discharge. I do not vouch for this treatment as a sure thing. Had the profession a sure preventive to the return of furunculous abscesses, many a suffering man, and woman too, would to-day be happy instead of miserable. Only the other day a young lady called, whom I treated four years ago for frequently returning furuncles. At that time, as fast as one would begin to get better, another would begin to come. She still has her boils, though not as bad as formerly.

Whoever furnishes this much-desired preventive will render a service in otology for which he can never be repaid. Who will discover the remedy?

OTITIS DIFFUSA (externa).—This is the name given to diffuse or general inflammation of the external meatus, to distinguish it from circumscribed or follicular inflammation above described. In the beginning, it is mostly acute, and, if not treated, usually subsides into a chronic form, which may continue indefinitely.

As in furunculous otitis, so in diffused otitis, all classes are subject to it. The condition of the general health may modify its severity and duration, but does not control it. *Scrofulous* people, particulary children, suffer more from it than any other class, though the strongest may have it.

Exciting Causes.—These, aside from the eruptive diseases, are very similar indeed, if not identical, to the exciting causes of follicular otitis.

The *exanthematous* diseases are the most common exciting cause of diffused otitis. The different eruptions of the general skin break out in the skin of the meatus, and a diffused otitis, usually acute, follows. Chronic or subacute otitis not unfrequently accompanies constitutional syphilis.

Besides these eruptive diseases, exposure to cold, strong wind, a draft on the ear from a small opening, cold or hot water in the ear, picking or scratching the ear, medicated solutions, frequent syringing, repeated introduction of oils or fluids of any kind, may be enumerated as the commonest exciting causes. Acute otitis may result from the presence of a foreign body in the ear, or it may follow its removal, particularly if violence has been used.

Diagnosis.—*Subjective Symptoms.*—The development of diffused otitis is the same as that of circumscribed otitis, except perhaps it is not so rapid. According to *Troeltsch*, itching is about the first sensation in the ear; scratching does not allay, but increases it. Soon a burning feeling is added; then pain begins. This gradually increases in severity. The pain at first is confined to the ear, but soon extends to the surrounding parts, just as in furunculous otitis. That there should be a similarity in symptoms is very natural. The inflammation involves the same structure, the swelling presses upon the same nerves, and, of course, analogous symptoms follow. In diffused otitis the inflammation involves the membrane (see Membrana Tympani) to a greater extent, producing more noises in the ear and a greater degree of deafness of a more persistent nature. The pain extends to the corresponding side of the head and may involve the entire head. Every movement of the auricle, of the lower jaw, and motions in the throat in swallowing, increase the suffering in severe cases. The cervical glands, particularly in children and young people, inflame either from sympathy or from absorption of poisonous material from the meatus. The suffering is usually greater at night, when considerable febrile excitement may be observed.

These grave symptoms, however, appear only in the acute and severer cases; in the chronic and milder form the patient may not be aware of the fact till his ear begins to discharge.

Objective Symptoms.—Upon the objective appearances in the meatus, when examined, will the physician have to depend in making his diagnosis, particularly so in distinguishing the diffused from the circumscribed otitis. A failure to make a correct distinction, however, would not be fatal, as the treatment is almost identical in each. In the examination of the ear early in the acute cases, every movement of the meatus produces pain; the patient will not allow the least pulling upon the auricle; the introduction of the speculum is very painful, and consequently it must be manipulated very carefully and gently. The skin of the meatus is uniformly swollen, and the calibre of the ear is contracted in consequence of the swelling. The skin is more or less injected in the beginning, but it does not become intensely red, for the reason that the epidermis begins to loosen very early and hides the intense injection of the true skin. Very soon the epidermis begins to detach in the form of scales; occasionally the entire epidermis is detached in an unbroken form, and, when removed, shows a regular mold of the meatus, including the membrane. When the skin is thus totally or partially denuded, its intense redness is easily seen. When there is considerable effusion of serum beneath the skin, the meatus is obliterated by the swelling, and an examination of the deeper-seated parts is impossible. Whenever it is possible to see the membrane (see its diseases), its surface will be found much injected. The epithelium of the membrane undergoes the same changes and is detached in pieces or as a whole. The denuded points in the membrane show very red, and give its surface something of an *ulcerated* appearance. In fact, ulcers may actually develop and lead to perforation; but more of this hereafter under Diseases of Membrane. But, as soon as the desquamation of the epithelium begins, a watery secretion from the true skin sets in and the ear begins to be moist. This becomes thicker and thicker, and in the course of twenty-four or forty-eight hours it becomes purulent and results in *otorrhœa.* As soon as the watery secretion begins to form the pain begins to ease, and by the time it changes to pus it has ceased entirely, which will take from two to four days from the beginning of the inflammation. During this time, as a rule, the patient gets no sleep on account of the suffering, and he is always ready to hail with joy the stage of suppuration which brings him so much relief.

If the examination is not made early in the progress of the disease, the meatus may be found full of epithelial scales, which will have to be removed before the deeper-seated parts can be seen. These should be syringed out with warm water or removed very carefully with forceps.

The swelling and pain are usually less in cases of diffused otitis following the eruptive diseases than from other causes; the general result of all is the same otorrhœa.

The symptoms in *chronic otitis diffusa* are less marked in character. The swelling of the meatus is very slight. There is very little, if any, soreness or tenderness upon pressure. There are denuded red patches in the skin and red points in the membrane where the epithelium has scaled off. Other portions of the meatus are usually covered with white flakes of epithelium in the process of detachment.

Generally there is more or less otorrhœa in the chronic form.

All these characteristic symptoms of otitis diffusa, acute or chronic, render the diagnosis easy.

PROGNOSIS is favorable so far as the suffering is concerned. The acute inflammation will run its course in from two to four days, and then subside into the chronic form, and otorrhœa will be the final result, which, without treatment, will continue indefinitely (see Otorrhœa below).

In prognosing it must not be forgotten that diffused otitis involves, not only the skin and subjacent tissue, but the periosteum also, which may involve the bone, and through that the inflammation may extend to the brain, and the life of the patient may be thus endangered. The possibility of such grave complications is particularly true of children, in whom the vascular connection between the meatus and membranes of the brain is quite close and extensive. In fact, these structures are only separated from each other by a thin layer of porous bone. However, these are rare complications; but such cases have been reported again and again, and the risk is sufficient to make every acute otitis diffusa a grave matter, and particularly so in young people and small children. Every physician knows how easy an infant shows brain symptoms from peripheric irritation of any kind. Serious consequences to the child therefore may follow the severe irritation of an otitis diffusa, not only from nervous sympathy, but also by actual extension of the inflammation to the membranes of the brain.

As to the hearing, the prognosis is not altogether favorable. The membrane (see its diseases below) is always more or less involved, and may be permanently injured, and the hearing proportionately defective.

But the above remarks apply to the probable course and possible complications of cases not treated at all. With early and correct treatment a favorable prognosis can always be made.

PATHOLOGY—The pathology of otitis diffusa is *simple inflammation* (whatever that may be) of the soft parts of the external meatus. The skin, the subjacent tissue, and the periosteum all seem to be involved. Whether the inflammation is spontaneous in all at the same time, or whether it begins in one and extends to the rest, is not known. It is impossible to diagnose separate acute inflammation of the different structures. This fact might be inferred from the very close anatomical relation which the parts bear to each other. In the anatomy of the meatus, it will be remembered, it was stated that some authors are disposed to consider the skin and periosteum toward the bottom of the meatus as one membrane. On account of this very *close* relation, to say the least, an inflammation in one that would not involve the other, would be next to impossible. So I consider that otitis diffusa is an inflammation of all the soft parts of the meatus. There is nothing in its nature that would indicate that the process in the ear is different in any way from inflammatory processes in other parts of the body.

TREATMENT.—This is very similar to the treatment of furunculous abscesses; in fact, it may be said to be *identical* with that, except the use of the knife. Internal treatment is not often necessary, but, if there should be any particular indication for internal medication, that should be attended to. The external meatus should be kept clean by gently syringing it with warm water. If the meatus is so much swollen that it can not be cleansed with the syringe, then the parts should be carefully dried with cotton wrapped around the end of a probe. This should be worked easy through between the swollen walls down toward the bottom, so the cotton will absorb any fluid that may collect there. The secretions must not be allowed to remain in the ear, as they irritate and aggravate the trouble. Warm fomentations should be applied, not constantly, but frequently, for half an hour at a time. The best application of this kind is to fill the ear frequently with warm water. If poultices are used, they should not be kept on more than half an hour at a time, as fresh air should not be shut out from the ear very long. As a means of applying moist heat, I direct the use of hop-poultices a great deal. They are very soothing and clean, and have something of an anodyne effect in relieving the suffering. But for anodyne purposes I am in the habit of using morphine and atropine solutions, either alone or in combination, for *all painful* affections of the ear.

Recently, I prescribe atropine (1 to 5 grs. to ounce of water) to the almost total exclusion of all other anodynes, simply because it is the most effectual of all. I use it a great deal in otitis diffusa. The solution may be dropped into the ear every hour till the pain is relieved. In children it can be used safely, but must be cautiously used.

My treatment in the early stage, as is seen from the above, consists in: 1. Cleanliness; 2. Warm fomentations (moist heat); and, 3. Anodynes locally (mostly atropine). From all of which it will appear that my plan is to get the ear to discharging as soon as possible by promoting suppuration. This, I think, is the quickest and safest treatment. I make it a rule to wait till the suppuration is fully established before I begin to check it. Formerly, following the advice of some of the older writers, I began to use astringents and caustics as soon as the watery secretion made its appearance on the surface of the skin; and, in doing so, I caused a very severe attack of fresh inflammation in a number of cases. Now, I prefer to wait till the suppuration has fully begun, and even till it has progressed somewhat, before I begin the use of astringents and caustics; even then I think it best to begin with rather a mild solution, and increase as the ear will tolerate it. Any of the astringents, as tannin, zinc, lead, borax, alum, copper, may be used; but I much prefer, and nearly always use, compound nitrate of silver (equal parts of silver and potash) in solutions varying in strength (from 5 to 40 grs. to ounce) according to particular indications in each case. An ear that suppurates freely, will bear and requires a stronger solution than an ear with slight discharge of pus or a discharge of water and pus mixed. The strength I most generally use, and most nearly suits all cases, ranges from fifteen to thirty grains to ounce of water. In infants and small children it must be much weaker (5 to 10 grs. to ounce). Instead of the compound nitrate, pure nitrate of silver may be used, but in half the strength of the above. At first, I repeat again, the treatment must not be too strong, for fear of an acute relapse of the otitis. In the beginning, four to six drops should be dropped into the ear once a day, for about two days, and afterward twice a day, always syringing the ear first with warm water. It is important not to allow the secretions to collect and stand in the meatus, as it prolongs the discharge and seriously endangers the integrity of the membrane. The medicine should be allowed to stand in the ear from one to two minutes, and then let run out on a rag, and the ear should then be wiped perfectly dry. I am in the habit of advising against the use of cotton in the ears or tying them up, except where it is necessary to use hop or other poultices; and these, as stated, should stay on only a little while at a time. I consider that fresh air is beneficial, rather than injurious, to an inflamed meatus, as already stated in the treatment of furuncles and eczema. This treatment must be continued till the suppuration ceases and the ear gets well, which will require from six days to three or four weeks.

If, with the warm fomentations and the local use of anodynes, it is impossible to relieve the pain, then opiates may be given internally, or a solution of morphine may be used hypodermically about the ear. If the latter method is used, it is better to begin with a small dose, and increase if necessary.

It will be observed perhaps that in the above treatment I have not recommended an *antiphlogistic* course, such as leeches, purges, and low diet. I do not believe in that kind of treatment for this kind of trouble. Purgatives influence the local trouble so little I do not think it worth while to trouble the patient with them. Low diet is rarely, if ever, advisable. Nature works best when nature's *wants* are supplied. I have never seen the good effects from leeches that others report; still, I have no *objections* to their use. They should be applied in front of the tragus; never in the mouth of the meatus, as their bites would increase the inflammation of the skin. From two to six are usually recommended.

Troeltsch recommends an antiphlogistic general treatment, purgatives, low diet, and leeches, and weak solutions of zinc, alum, copper, etc., to check the secretions.

Gruber recommends the same course of general treatment with the addition of deeply scarifying the meatus, early in the disease, in several places, as he recommended in furuncles.

Some years since I treated a young woman for a severe attack of otitis diffusa. There was intense suffering and great swelling, the meatus being completely closed. Following the suggestion of some of the English writers, I applied a strong solution of nitrate of silver to make the swelling go down; but it had a contrary effect and made it worse. I became somewhat impatient (she was clamoring for relief), gave her chloroform two or three times, and each time incised the meatus clear down to the bone in several different directions. Each time there followed a fresh attack of inflammation and increased suffering.

From that experience I learned to be a little more patient, and to wait for and hasten all I can the suppurative stage, before I begin the use of caustics or astringents, as the quickest and safest method of treatment, as already indicated.

In otitis diffusa I prescribe atropine with a twofold object in view: 1. On account of its powerful anodyne effect; and 2. On account of its very favorable, so to speak, antiphlogistic action upon the membrana tympani. Its use will come nearer insuring the integrity of the membrane than any other application I know of. (For details see Diseases of Membrana Tympani below.)

Finally, I may remark again that it is of the first importance to prevent, as far as possible, the constant bathing of the membrane in the secretions of the meatus, by frequently cleansing the ear.

OTITIS PARASITICA (aspergillus).—Several writers* (Wreden, of St. Petersburg, taking the lead) have recently described a form of otitis in connection with which a vegetable parasite of the mushroom variety (aspergillus,—Wreden) has been discovered. The form of inflammation seems to resemble diffused otitis, in both subjective and objective symptoms. Its distinguishing characteristic seems to be an indisposition to suppurate and a constant tendency to the formation of a white, tough, lardy mass on the surface of the skin and membrane, often filling up the bottom of the meatus completely, and seriously interfering with the power of hearing.

This mass is composed of epithelial scales, hairs, and sometimes wax. In its substance the microscope reveals the presence of the vegetable parasites in great number. They seem to prefer the bottom of the meatus and the surface of the membrane, as the parts most favorable to their development.

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*Wreden, Schwartze, Weber, Green of Boston, Roosa, Knapp, Turnbull, Mayer, Gruber, may be named.

This mass is sometimes so tough and adhered so closely that it can not be moved with the syringe, and has to be picked away with the bent forceps (see Fig. 10).

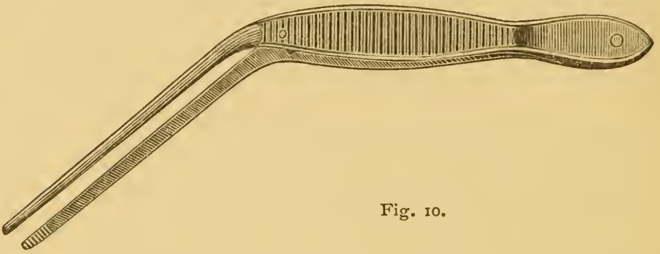


Fig. 10.

It is not yet definitely settled whether the inflammation or the parasite is the primary trouble. The weight of authority seems to indicate that the parasite is the exciting cause of the otitis, which is usually persistent and troublesome.

Treatment.—Of course they must be removed and their reproduction prevented. A part of the authors referred to say that the frequent use of the syringe and warm water is sufficient to destroy them. Others recommend astringent solutions, as tannin and sugar of lead. *Gruber* particularly advises the use of a solution of carbolic acid (5 grs. to ounce of water). *Theoretically* I would agree with him in the probable efficacy of carbolic acid. I would be disposed to use a stronger solution (5 to 10 grs. to ounce of water), about twice a day, taking special pains to cleanse the ear thoroughly before each application. The general *anti-parasitical* property of carbolic acid is well known.

Narrowing of Meatus may occur: 1. From cicatricial contraction of the soft parts, following ulceration.

Fig. 10.—Bent forceps. Valuable instrument for removing crusts and small objects from the meatus.

I have seen it occur after ulceration of the cartilage near the orifice of the meatus.

Treatment in such contractions does not avail much. The cicatrix may be forcibly dilated, and kept so for months and months, with an almost certainty that it will recontract when the foreign substance is left out. I therefore advise the dilatation of such cicatrixes only where it is necessary to remove, or to treat any urgent trouble in the bottom of the ear.

2. From hypertrophy of the soft parts or from serous effusion beneath the skin. The former is a thickening of the skin, periosteum, and perichondrium. The latter is an effusion—a kind of dropsy—between the two. Both result probably from very chronic inflammation.

The *treatment* consists in making or causing appropriate pressure by the introduction of bougies of laminaria digitata or compressed sponge, or perhaps still better by tamponing the meatus with narrow strips of soft rags, packed in with a probe. Of course these must never be pressed down against the membrane, and must be removed as often as they get unclean. The pressure promotes absorption. *Gruber* says it will sometimes be necessary to deplete the parts by deeply incising the skin before using pressure.

Exostosis is a small round conical growth of bone that not unfrequently develops in any of the walls of the meatus. There may be one or more in the same ear, or in both ears at the same time. Sometimes one is large enough to close the meatus; at other times smaller ones grow from opposite sides and meet in its centre. In structure it is very hard and firm, and for this reason it is said to be *eburnated*—hard as ivory.

It develops usually slowly, and does not interfere with the hearing till it begins to obstruct the meatus.

Its Pathology is not known. Sometimes it can be traced possibly to a syphilitic origin, but it is impossible to say that that is always its origin.

Treatment.—If any syphilitic taint can be detected about the individual, he should, of course, have anti-syphilitic treatment. In other cases internal treatment is of no service.

The surgical treatment consists in removing the growth. That, however, is somewhat risky and should be attempted only where there is some very urgent reason for it, as when there is collection of pus beyond the growth, and has no way of escape. In such a complication the pressure upon the deeper parts gives rise to serious cerebral symptoms and endangers the life of the patient. Under such circumstances surgical interference is not only justifiable, but absolutely necessary, in order to save the life of the patient.

According to *Gruber* the exostosis should be cut away with a *chain-saw*. That, however, is not always practicable.

General surgeons would say, "Chip the growth off with a chisel." That would certainly endanger the life of the patient on account of the necessary violence and possibility of producing a deep fracture of the bone.

I would prefer to remove it by drilling successive holes through its base until it was so weakened that a small amount of force would detach it.

Sufficient pressure to make it absorb can not be tolerated by the patient. Some years ago I saw a man whose meatus was completely obstructed by an exostosis growing from posterior wall. Beyond the tumor the meatus was completely filled with a plug of wax.

I tried to dilate the meatus, sufficient to remove it, by pressure, but did not succeed. The pressure caused the skin covering the tumor to ulcerate and denude the bone, but sufficient space could not be produced through which to remove the wax. The patient finally got tired of the somewhat painful and slow process and ceased to come.

HYPEROSTOSIS is a hypertrophy of the general surface of the bony walls, and is characterized by a regular contraction of the entire meatus. It is not very common and may occur in both ears at same time. The contraction is not often sufficient to close the meatus and obstruct the hearing.

Its *exciting cause* is supposed to be the constant bathing of the skin of meatus in purulent secretions, as in otorrhœa. (*Roosa.*)

ITS PATHOLOGY, according to *Troeltsch*, is a chronic periostitis in the meatus.

TREATMENT.—If there is otorrhœa in connection with the bony contraction of the canal, that ought to be treated. (See Otorrhœa below.)

If there is any constitutional trouble, as syphilis, that should be treated accordingly. Local treatment avails nothing.

EPITHELIOMA sometimes (rarely) develops in the outer part of the external meatus. It presents the general characteristics of epithelial cancers in other places and must be similarly treated. The prognosis is very unfavorable on account of the impossibility of its being removed with the knife. It has to be destroyed with escharotics, and that, in the external meatus, is a severe and hazardous process.

Some years since I saw a man with an epithelial cancer, involving the outer part of meatus and inner portion of concha. It had already destroyed the skin and caused the meatus to contract to a mere point, from which came a very offensive discharge from the bottom of the ear. The quacks had put him through, as usual, and had only aggravated the trouble.

On account of the necessarily very unfavorable prognosis the man did not go under treatment.

Middle Part of the Ear.

As already stated, this part of the ear is composed of *membrana tympani*, *tympanum*, *Eustachian tube*, and *mastoid cells.*

Membrana Tympani.—This forms the dividing line, the partition between the outer and middle parts of the ear, and pertains anatomically to both ; but, as it is the head of the drum (tympanum), it belongs more properly to the middle part.

Anatomy.—The membrane is stretched across and consequently closes the external meatus at its inner extremity. Its plane does not cut that canal at right angles, with respect to its axis, but has an oblique position ; the inclination being *inward* from above and backward, downward, and forward. On account of this oblique position of the membrane, the walls of the meatus have, as stated above, different lengths ; the upper and posterior are the shorter, the lower and anterior the longer. The membrane forms an obtuse angle with the upper wall, and, for this reason, in syringing the ear, it is best to direct the stream of water along the upper wall, as it will not strike so squarely against the surface of the membrane ; with the lower wall the membrane makes quite an acute angle—in fact, it forms something of a pocket, in which foreign bodies might escape observation.

The physiological reason for the oblique position of the membrana tympani is not well understood. Some writers (Bonnafont and Schwartze) intimate that the membrane has a striking vertical position in musicians, to which *Troeltsch* adds that he had noticed its marked obliquity in persons of no musical taste.

Early in childhood, and before birth, the membrane has nearly a horizontal position, and, as the base of the skull develops, it approaches the vertical direction.

In the general development, in fœtal life, of the temporal bone there is a distinct special bone formed for the attachment of the membrana tympani. This bone is called *annulus tympanicus* (see Fig. 11), and, as its name implies, is ring-shaped, but does not form a complete ring, there being a small defect or break at the upper and back part. About birth, it unites with the squamous portion of the temporal bone. Soon after birth, the processus auditorius develops outward from the annulus tympanicus, and forms the bony part of the external meatus. In early infancy, therefore, there is very little bony meatus, and consequently the membrane is comparatively near the surface. On the inner margin of the annulus tympanicus is a small groove, *sulcus tympanicus*, which is a permanent groove on the inner extremity of the external meatus of grown persons. In the sulcus tympanicus the margin of the membrana tympani is attached by means of a kind of fibrous ring that encircles the membrane, and is defective only above, corresponding to the break in the annulus tympanicus;

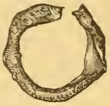


Fig 11.

Fig. 11.—Annulus tympanicus (open above).

at which point the membrane is less firmly attached to the bone, and consequently is most likely to give way from internal force, as too violent inflation (*Troeltsch*).

In regard to this connecting ring between the membrane and sulcus tympanicus, a sharp controversy has sprung up between the German writers particularly. One party says that the ring is *membranous* only, and name it accordingly, annulus *membraneus;* the other party claims that it is *cartilaginous* (contains cartilage cells), and consequently call it annulus *cartilagineus.*

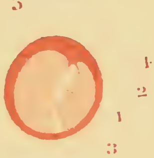
Whatever the truth may be in regard to the matter, the question has no practical importance.

The membrana tympani varies, in size and physical form in a state of health, so much that it is difficult to find any two alike, and *very* difficult to find what might be called a *physiological* membrane in every respect. The accompanying lithograph will give at least a *good* idea of the natural appearance of such a membrane (see lithograph).

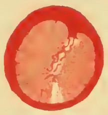
In its outline, it has an elliptical form, with the long axis nearly vertical. In health, it always has a bright lustrous, glistening, or shiny appearance. In color, the membrane varies very much. It may be said, in a general way, that it has a very light rose color, or white color very slightly tinged with red. But it must not be forgotten that the color is modified by numerous circumstances, as shown by *Politzer;* such as its thinness, its nearness to the opposite wall of the tympanum, its obliquity with respect to the canal, opacities in its substance, the different kinds of light with which it is illuminated, and so on. All these circumstances modify or intensify the color, so that it is impossible to give a definite idea as to the natural color of the membrane.

The annulus tympanicus and the membrane are well

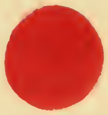
Physiological Membrana Tympani.
[Approximate.]



1. Handle of malleus. 2. Short proces. 3. Cone of light. 4, 5. Anterior and posterior folds.



Acute myringitis.
(Incipient.)



Acute myringitis.
(Fully developed.)

developed at birth, and the membrane increases but very little with age. Strange as it may seem, the membrane in an infant is nearly as large as in an aged person.

Minute Anatomy.—The membrana tympani is composed of three layers—the outer, the middle, and the internal.

The outer layer is derived from the skin of the external meatus, which, in a modified form, is reflected over the outer surface of the membrane, and forms its first or outer layer, which is much thinner and more delicate than the skin of the meatus; it contains no glands, no papillæ, and very little connective tissue (Politzer). This layer is a material support to the general strength of the membrane.

The middle layer is the chief or principal part of the membrane, both in strength and bulk, and is called *membrana propria*, to indicate that it is the membrane proper, the other two layers being accessory to it. This layer is composed of fibres, which are arranged in two sets—the *radiating* and *circular*. The first take their origin from the annulus tympanicus, or from the tympanic connecting ring above described, and run inward toward the centre of the membrane, and are attached to the handle of the malleus (manubrium mallei), which is imbedded in the membrana propria, a little external to its centre. These fibres become thinner and thinner toward the upper margin of the membrane. Their arrangement about the handle of the malleus produces a fan-like appearance.

The circular fibres are internal to the radiating, and differ from them in not forming a complete lamina. At the extreme margin of the membrane there are no circular fibres, but are thickest only a little internal to the margin, and then grow thinner and thinner, and disappear almost toward the handle of the malleus. They take their origin from the malleus handle, make a circle around it, and are attached to the opposite side.

No blood vessels have ever been discovered in the middle layer of the membrane, but, like the cornea, it must be nourished by blood from some source.

The internal layer is simply a part of the mucous membrane, which lines the entire cavity of the tympanum, and presents the characteristics, in the main, of mucous membranes in general, except that it has much less connective tissue, and consequently is much thinner and much more delicate.

THE BLOOD VESSELS of the membrana tympani are characteristically divided into two distinct sets. The external layer has its own blood vessels, derived from the skin of the meatus, and the mucous or internal layer has its own blood vessels, derived from the mucous membrane of the drum. These two sets anastomose only at the periphery; never through the substance of the membrane, so far as is known. There is quite a tuft of blood vessels that passes to the membrane from above, and runs down over the handle of the malleus to its lowest extremity, and supplies the adjacent portion of the outer layer. These become visible upon the slightest irritation.

The arrangement of the *nerves* of the membrane is not well understood. The nerve filiments of the external layer seem to accompany the blood vessels. The middle layer contains none at all, and it is still a question whether the mucous or internal layer contains nerves or not.

In the substance of the membrana propria, among the radiating and circular fibres, numerous corpuscles are to be seen, which are supposed to be peculiar to the membrana tympani. They were first described by *Troeltsch.* In appearance, they are somewhat analogous to the corpuscles of the cornea (*Politzer*).

The nature of the attachment of the fibres to the handle of the malleus is not settled. Most of the writers agree that they are attached directly to the handle; but *Gruber* holds that the fibres are attached to a *cartilaginous body*, which lies upon the malleus handle, and is connected to it by a regular *joint attachment.* In his recent work he gives cuts illustrating his idea.

On the inner surface of the membrane, at its upper posterior and anterior margin, two folds are to be seen, which run from the back and front edge of the membrane to the handle of the malleus, so as to form two pocket-shaped cavities or openings with the inner surface of the membrane. These are called respectively *anterior* and *posterior pockets* by *Troeltsch*, who first discovered and described them at length. He claims that these are actual duplicatures of the membrana tympani, which assist materially in holding the malleus in place. On the contrary, *Gruber* denies that these are duplicatures of the entire membrane, and claims that they are only folds of the internal or mucous layer, as he has failed to find fibrous elements in them.

The handle of the malleus is imbedded in the membrana propria, and its position is indicated on the outer side of the membrane by a white line, running from above downward and backward to a point a little in front of its centre, thus dividing it into two unequal parts, anterior smaller and posterior larger.

At the upper end of this line, just within the upper margin of the membrane, a small round tubercle, short process of malleus, is seen projecting outward, lifting the membrane somewhat at that point. A white round spot usually shows its position.

Running upward, backward, and forward from the short process, two red folds, or thickened bands, of the external layer are nearly always visible, their bright redness making a sharp contrast with the pale redness of the general membrane. These folds (anterior and posterior) give the membrane sometimes a heart-shaped appearance. The anterior is smaller and the posterior larger. It is possible that they bear some close relation to the folds on the inside, described above.

The membrane, as a whole, does not form an even plane across the bottom of the meatus; its centre, or central portion, seems to be pressed or drawn inward, making the external surface concave and the internal proportionately convex. This concavity of the membrane seems to be produced by traction upon it by the handle of the malleus. The most concave point of the membrane is called *umbo*, as it is depressed somewhat like an umbilicus; the extremity of the malleus handle indicates the point.

Upon the anterior lower part of the membrane a light spot is seen, of triangular shape, with the apex pointing to the end of the handle of the malleus, and the base corresponding to the anterior lower margin of the membrane. This is called the *light spot*, *triangular light spot*, *cone of light*, *speck of bright light*. It is simply a reflection of the light from that point back to the eye. *Politzer* has investigated the matter thoroughly, and concludes, in substance, that, in order to have a reflection from a membrane viewed obliquely, that membrane must be curved; in consequence of the curvature, portions of the membrane are so changed in position that the light strikes perpendicularly upon the surface, and consequently is reflected back to the eye. The necessary curvature is given to the membrana tympani by traction of the malleus handle; hence the light spot makes its appearance, and is regular and irregular, large or small, according to the laws of reflection from curved surfaces, whether concave or convex.

EXAMINATION OF MEMBRANE.—The external meatus and membrane are to be illuminated in the usual way. A speculum must first be introduced, and then the light is reflected in through that.

Occasionally prominences or irregularities in the walls of the meatus may hide or cover up portions of the membrane, and make it difficult to get a good and satisfactory view. In such cases the examiner must manage to see past these in whatever way his judgment may indicate. But in normal auditory canals no great amount of difficulty is to be anticipated from this cause.

In examining the membrane it is not possible to get a view of the entire membrane at the same time; consequently the speculum must be turned in different directions so as to bring different parts into view in quick succession, and in this way an opinion of the condition of the whole may be formed.

WHAT TO LOOK FOR.—*The landmarks* (so to speak) of a healthy membrana tympani are furnished by the anatomy and may be arranged about as follows:

1. The general color of the membrane; a very light rose color, or white slightly tinged with red.

2. The little prominent white spot at upper margin of the membrane, projecting outward, and is called the short process of malleus (processus brevis mallei).

3. The white line (sometimes slightly yellowish) running from above (a little forward) downward and

backward to near the centre of membrane; its extremity may be a little flattened or spread out.

4. Beginning at the end (or near it) of the malleus handle, and extending downward and forward to the periphery, or nearly so, is the cone of light or light spot, the size and shape of which is very variable in health.

If all these outlines of the membrane are found to be in a *normal* condition, then the opinion follows that the membrane is healthy.

Anomalies in Health.—The color of the membrane is by no means uniform. It may be pearly white; it may have a dark rose color; and the tuft of vessels along the malleus handle may be injected so as to show a dark red line in their course, together with the deep redness above in the anterior and posterior folds of external layer, and still the membrane be *healthy*, so far, at least, as its function is concerned. The tuft of manubrium vessels passes in either from or through these folds, and consequently there is a close sympathy between them; the slightest irritation, as introduction of speculum or syringing, may produce a decided congestion of the malleus vessels and those of the folds.

The white spot or short process varies from a mere point to a spot double the size of a pin's head. It is sometimes red instead of white, but it can always be recognized by its projection.

The white line of the manubrium varies considerably in width, may be slightly curved, and broader at each extremity. Congestion of the malleus vessels sometimes makes it red instead of white.

Just in front of the handle a sharp deep depression in the membrane is occasionally observed in ears that hear perfectly.

The cone of light varies from a mere point to a large triangle. In fact, it is sometimes absent entirely. This variation in the light spot depends upon different degrees of inclination and curvature of the membrane, which do not interfere with the power of hearing.

The membrane, in health, should always show a *lustrous* or *shiny* appearance, which may vary some in degree.

As to the membrane substance, every aural surgeon well knows that perceptible changes may take place in it without interfering with the hearing power in the least. *Politzer* thinks that such changes are the result of old diseases that have entirely recovered, or that they may be due to congenital malformations.

The same author has described large calcareous deposits in different parts of the membrane where he could discover no defect in the hearing. Such abnormal conditions, however, with perfect hearing are very rare.

All these anomalies may be met with in the ears of persons who have perfectly *normal* hearing. On the contrary, cases are not uncommon where there is decided dullness of hearing, if not *actual* deafness, whose ears show perfectly normal or physiological membranes. So, therefore, the aural surgeon must be very careful in giving his opinion in regard to the acuteness of hearing from the appearances alone of the membrane. These are often *very deceptive.* He can only approach the truth in giving the probabilities in the case.

Army surgeons sometimes have to solve knotty questions in cases of *feigned* deafness, where no reliance is to be placed in what the individual says. It is impossible to tell whether a man can hear or not from the appearance of the membrane. The probability in the matter is the limit to anybody's skill.

INJURIES OF THE MEMBRANE occur rarely, on account of its well-protected position.

In fractures through the base of the skull the petrous bone may be fractured and the membrane ruptured, as would be indicated by hemorrhage from the ear. This is regarded by surgeons as a very serious symptom after an injury to the head, as it strongly indicates a fracture about the base of the brain.

Ruptures may occur from violent concussion, as in artillery practice. *Gruber* denies that this is sufficient to rupture the membrane, except where it was previously diseased. I have seen officers, who believed that artillery shooting ruptured their membranes, besides cicatricial evidences could be seen in them. *Roosa* reports a rupture from a pistol shot near the head. Hanging may rupture the membrane, as reported by Wilde.

Rupture may occur from a blow (humanely called a slap) with the open hand over the auricle. Children suffer injury in their ears from this cause not so unfrequently as might be supposed. A blow with the fist is not so apt to cause a rupture.

Sticks and straws are sometimes accidentally thrust into the ear and penetrate the membrane. Fractures of the malleus may occur in this way (*Troeltsch*).

Foreign bodies are frequently pressed through the membrane, or against it with sufficient force to rupture it, in unskillful and awkward efforts to remove them.

Careless probing or picking of the ears may rupture the membrane.

Fracture of the malleus handle is very rare. Only a few cases have been reported with causes similar to those of ruptures. When fractures occur, the individuals often faint (Troeltsch).

Diagnosis is easy. It is only necessary to look at the membrane and the seat of the rupture in the fresh state can be easily seen. The patient will usually be able to blow air through it by the well-known Valsalvian method. At a later period its location can usually be recognized by the cicatrix. Fractures of the malleus handle are not always so easily diagnosed.

Treatment.—Here there is great danger of doing, or trying to do, too much, and very little danger of doing too little.

If the blood accumulates in the ear, it should be syringed out gently, and then the patient should be let alone. Simple ruptures heal without trouble.

The healing process in fractures of the manubrium requires considerable time, just as fractures in other bones; and the whole process has to be left to the powers of nature, as it is impossible to get down to the parts to coapt and hold them in position. On account of the almost constant movements of the parts the fragments rarely unite in a straight position, but usually at angles. This can not be avoided The seat of fracture is mostly observed just below the short process; and after union has taken place, the cicatrix may remain visible for a long time.

If pain follows any of these injuries, anodynes must be used locally and given internally.

If inflammation sets in, that must be treated *mildly* on general principles, taking extra care not to interfere with the healing process. The parts should be kept at rest as far as practicable. To this end the patient should be directed to refrain from coughing, sneezing, and blowing his nose, so as to avoid driving the air into and through the ear, as that would interfere with the healing of the ruptures and fractures.

Diseases of Membrana Tympani.—From the anatomical structure and relations of the membrane, it would be inferred that it would frequently be the seat of both *primary* and *secondary* disease. Contrary to this natural inference, *spontaneous*, *primary*, *independent* diseases do not very often develop in the membrane originally; but, on the other hand, *secondary* troubles, the result of complications of other diseases in associate parts, are very common. Indeed, it may be said that there is always more or less involvement of the membrane in all acute inflammations of the external meatus and of the cavity of the tympanum. The reason for this is very evident. The skin of the meatus, as the anatomy shows, forms the outer layer and the mucous membrane of the drum the inner layer; hence the diseases of both very easily extend to the membrane by continuity.

It has already been stated, under the head of Otitis Diffusa, that the membrane is always more or less affected by that disease. *Gruber* goes so far as to say that ulceration and perforation of the membrane is the *rule* in connection with diffused inflammation of the meatus. My experience does not show such uniformly serious complication as that.

Hereafter it will appear that acute inflammations of the cavity of the drum endanger the integrity of the membrana tympani still more uniformly and much more seriously. (See Diseases of Tympanum below.)

A very good reason why acute diseases of the meatus and of the drum should so uniformly involve the membrane, may be found in the not only possible, but even probable derangement of its nutrition, either by cutting off the supply of arterial blood to it or preventing the return of the venous blood from it. As has already been seen, the blood supply reaches the membrane from two sources—the skin externally and the mucous membrane internally. Consequently, it is very easy to understand how acute inflammation in either of these structures, with the usual amount of swelling and consequent pressure, might cut off, in the first place, the supply of blood to the membrane, and, in the second place, prevent its return from it. In either case, the result would be a *tendency* to ulceration and perforation, with a kind of *passive* congestion of the membrane. If both should be involved in acute inflammation at the same time, sloughing even would probably result.

It is a well-known fact that pressure around the margin of the cornea sufficient to interfere with its nutrition will cause it to ulcerate and sometimes to slough.

Why should not the same thing take place in the membrana tympani under much more favorable circumstances for its production? The bony walls make the interruption of the circulation in the ear much easier and completer than in the cornea, where there are no surrounding bones.

It seems to me that this is one of the causes of the frequent complication of the membrane in the diseases of its associate parts.

With this understanding of the matter, the speedy restoration of the interrupted circulation becomes an important matter in the treatment.

The changes that take place in the membrane are not difficult to recognize in a general way. It is, however, to be supposed, that every physician is acquainted with the natural appearance of a healthy membrana tympani.

This little bit of knowledge is absolutely necessary to progress in otology. Beginners should embrace every opportunity to examine and compare physiological membranes, so as to form a correct idea of their appearance and variations in health; then they will be prepared to examine pathological membranes, and to recognize pathological changes when they see them.

The changes that take place in the membrane in connection with otitis diffusa have already been referred to, and now it is only necessary to say that the membrane swells more or less, and that its outlines are proportionately obscured; its epithelium becomes detached, as a whole, or in part. When the loosened epithelium is washed away, the membrane shows quite red; if only portions are detached, then its surface will show red points, which may possibly develop into ulcers, and, in unfavorable cases, perforate the membrane. The subjective symptoms from the membrane can not be distinguished from those of the acute otitis diffusa.

Politzer, in his interesting little book on the membrana tympani, undertakes to distinguish between the individual diseases of each layer of the membrane. For instance, he describes the pathological changes that occur in the *epidermic layer*, in the *dermoid layer*, in the *fibrous layer*, and in the *mucous layer;* all of which is very nice in theory, and interesting in a professional scientific sense, but leads ultimately to confusion and doubt. Even if it were possible to make these finer distinctions in diagnosis, it would not change the therapeutics, which is about the same, whether one layer or all the layers are involved. Why, then, try to make such difficult distinctions when no practical advantage is gained by it? The membrane is hardly as thick as common writing-paper, and it is somewhat difficult to understand how that can contain four distinct layers, subject to distinct diseases. For these reasons, I do not undertake to make these fine (impossible) distinctions, but prefer to speak of the membrane as a whole, in describing its diseases. However, one slight general distinction may be made: Wherever these secondary affections of the membrane depend upon diseases in the meatus, the outer part of the membrane is mostly involved; wherever they depend upon the troubles in the drum, the inner part is mostly involved.

TREATMENT.—In all these secondary complications of the membrane with other primary diseases, the main treatment must be directed to those primary diseases. For the proper treatment of these affections, I must refer to Otitis Diffusa above and to Diseases of the Drum below. The treatment intended particularly for the membrane in these complications must be protective and curative. The first indication is met by keeping the ear clean. Collections of pus or watery secretions should not be allowed to remain in the ear. The constant bathing of the membrane in these secretions is a source of irritation, and of course aggravates the trouble, as already stated. Besides this, fresh air should not be excluded from the ear, as it has rather a beneficial than an injurious effect upon the membrane. Strong winds are to be avoided in all inflammatory affections of the ear. The *curative* treatment consists in the local use of atropine solution (from 3 to 5 grs. to ounce of water). I am in the habit of uniformly prescribing this in all diseases of the membrane, whether painful or not. Its use fills two important indications: First, it is the most powerful anodyne that can be used; and, secondly, it has a curative power in it, in diseases of the membrane, that I have never seen in any other remedy. The modus operandi I am not able to explain, but its "healing" power I have frequently witnessed. It seems to act specifically in diseases of the membrane, particularly when acute, as it does in corneal affections, in which its reputation is well established. I direct it to be dropped into the ear three to five times a day, according to the severity of the pain. Should be let remain in the ear about ten minutes, and even longer where the suffering is severe. Where there is a perforation, care must be taken lest too much should run through into the throat and affect the patient unpleasantly. As a rule, it is as harmless in the ear as in the eye. In children, the solution should be proportionately weaker.

The *primary*, *spontaneous* diseases of the membrane, as already stated, are but few; the leading and most common of which is

ACUTE MYRINGITIS, which, as is implied in the name, is *acute inflammation* of the membrana tympani. (See lithograph.) It is a rare, at least not very common, disease, but physicians who treat ear affections a good deal will meet with it occasionally. All classes may have it, from the most robust to the weakest. Persons whose health is somewhat below par, are perhaps most subject to it.

Traumatic myringitis is the result of some physical injury, and is often circumscribed—confined to injured portions of the membrane. This is not under consideration here. I speak now only of idiopathic myringitis, and I call it acute because it always develops in an acute form.

EXCITING CAUSES.—Exposure in cold, damp weather and in strong winds is the most frequent cause of myringitis. Consequently it is observed mostly in winter time. I do not remember that I ever saw a well-marked case in the hot part of summer. Cold water in the ear may cause it. *Troeltsch* has observed it after cold bathing. Many cases are literally *spontaneous*, where no immediate cause can be discovered.

Subjective Symptoms.—Acute myringitis comes on like a flash, without any premonitions whatever. It attacks, as a rule, only one ear, and, according to my experience, always begins in the night. Suddenly an individual is aroused from sleep with pain in his ear. This grows worse, instead of better, and soon gets to be severe in every sense. The patient, in a very short time, begins to think that the suffering is beyond all endurance. Sleep is out of the question as long as his acute myringitis continues. The pain soon extends to the surrounding parts, to the side of the head, and sometimes to the whole head, to the face and teeth on the corresponding side, and more or less down the neck. The movements of the jaw in chewing and swallowing may increase it, but this is not always the case. The auricle does not become tender to the touch, as in furuncles and acute otitis externa.

All this takes place usually in an incredibly short time after the first sensations of pain.

As the disease advances, the hearing becomes affected, and soon the ear is either very dull as to the power of hearing, or is almost totally deaf. A sense of fullness or stuffed feeling about the ear is often complained of. From the very commencement, the patient complains of noises in the ear, which grow worse and worse as the trouble advances, until finally, together with the feeling of fullness and pressure, they become almost distressing. These noises continue to the end, and are about the last symptoms to leave the patient.

Autophonia is one of the troublesome subjective symptoms. Patients say their own voices ring through their ears in a very unpleasant way every time they speak, and they often compare it to the noise made by speaking into the end of an empty barrel.

But the great and all-absorbing trouble in all cases is the pain, the *intense*, *fearful* suffering. Sometimes the sufferer will beg piteously for relief, if only for a short time, that he may have even a few moments of ease and rest. I think I have seen as intense suffering from acute myringitis as from any other known cause. If anybody wants to know what *pure* pain is, let him have an attack of acute inflammation in the membrane. The pain is always worse at night.

Objective Symptoms.—These are few, and very characteristic. The inflammation is confined to the membrana tympani, and the consequent changes are limited to it. In the very early stage (see lithograph) a congestion of the membrane is observable. The vessels along the malleus handle are injected. At the extremity of the manubrium, radiating blood vessels may be seen; at the outer margin of the membrane, individual blood vessels pointing toward its centre are often visible. The general surface of the membrane has an increased redness, but its outlines are easily distinguished.

This congestive stage, however, lasts but a very short time, not more than a few hours. The individual blood vessels are soon lost in the general redness, and the short process, handle of malleus, and cone of light are early obscured by the general swelling of the membrane. Now the surface of the membrane is even, and often convex externally, and presents a dull (not shiny) appearance, and has a dark red (like venous blood) smooth-flesh color. At this stage, the outlines of the membrane are entirely obliterated, so that it is difficult to tell what is membrane and what is not. This is the condition (see lithograph) in which the physician will usually see acute myringitis, as it is rare that the patient will apply for relief during the very short congestive stage. I have seen only one case in that stage. The line of union between the skin and membrane is entirely obliterated. The skin around the bottom of the meatus, in close proximity to the membrane, is considerably congested; but acute myringitis shows very little disposition to extend to the surrounding parts, either external or internal. This fact is somewhat remarkable, considering the intimate anatomical relations of the membrane to the associate parts.

The membrane and external meatus, as a rule, remain dry. I have only seen one case in which there was otorrhœa, and in that it was produced by caustic applications, as I thought, that were made before I saw him. (See details below.)

The epithelium of the membrane, in this dry condition, may crack in a zigzag line across its surface. I remember one case in which a line of this kind extended clear across the membrane from above, downward. I first took it to be a rupture.

I have never observed any disposition to ulceration of the membrane, except in the case where the discharge occurred, and there it had been injured with caustics; but no perforation took place.

Diagnosis.—The above subjective and objective symptoms render the diagnosis comparatively easy.

The most reliable of these are: 1. Sudden severe pain at night, that rapidly increases; 2. The annoying ringing of the voice through the ear every time the patient speaks; and, 3. The appearance of the membrane, its swollen condition, and uniform dark red color.

Sometimes there will be a question as to whether there is inflammation of the cavity of the tympanum. If the ear was previously sound, and there are no symptoms of catarrhal trouble about the throat, it may be concluded, with a reasonable degree of certainty, that the tympanum is free. Still, the presence of catarrh in the throat would not prove that the drum is involved; it would only make it more probable.

PROGNOSIS.—Without treatment the disease will continue indefinitely. I remember an old lady, who suffered from it for six weeks without abatement in the least, as she said; at the end of which time she came under my care (see below). With treatment, however, the prognosis is very favorable. The ear will rapidly recover, and the hearing will be fully restored in from ten days to three weeks.

PATHOLOGY.—The pathological condition in acute myringitis is that of acute inflammation, as the name implies.

TREATMENT.—This, as I direct it, is simple, easy, and effectual. It has been my custom for years to treat all cases of acute myringitis with atropine in solution (3 to 5 grs. to ounce of water). This I direct to be dropped into the ear from three to five times a day. At first it may be used every hour till the pain is relieved. It should be dropped in warm, and allowed to remain in the ear from five to ten minutes. Then I let it run out, and dry the ear with a rag and leave it free, except perhaps where the patient must go immediately into the strong cold wind; in that case it should be somewhat protected. I do not often think it advisable to exclude the fresh air from the ear.

As the cure progresses the solution should be used less and less frequently. I accidentally prescribed the atropine in the first case in which I used it. Since then I do not think of using anything else.

In all the cases in which I have used it, the pain has been entirely relieved in from ten to fifteen minutes, and it rarely ever returns; to my knowledge, it has never returned when directions have been followed.

The swelling very soon begins to subside, and the membrane rapidly regains its natural appearance; the short process, the handle of the malleus, and the cone of light reappear as the swelling disappears. The improvement in the hearing keeps pace with that of the membrane.

The noises begin to cease as soon as the physical changes in the membrane begin to subside. About the last trace of acute myringitis is seen in a congested appearance of the malleus vessels.

The recovery will take place in from four days to three weeks. One man, who did not follow directions, was under treatment about three weeks. Some were dismissed in less than four days.

All the cases I have seen occurred in grown persons.

Except in children, the atropine may be used in any strength. I sometimes put a little of the powder in. In which case, if there is no moisture in the ear, a few drops of water are necessary to dissolve it. Under no circumstances is the *anodyne*, as well as the *curative*, power of atropine so well shown as in acute myringitis. It not only relieves the intense suffering almost instantly, but it actually *cures* the disease. The atropine must have done the work, as nothing else was used in the cases to which I refer. *How* it does it, I do not know. I only know and give the facts.

I wish to refer to a case or two very briefly, illustrative of what I have said above.

Case I.—Mrs. B——, æt. 47, not robust naturally and much reduced by the long suffering, applied some years ago, at Cincinnati, for treatment, with the following history: Six weeks ago she was suddenly aroused from her sleep by intense pain in one of her ears. Since its commencement she declares she has not slept a wink, and continues to suffer as severely as at first, and begs piteously for relief from the pain that she might get a little rest—a few hours of sleep.

Such was her story, the burden of which was the great suffering and want of rest.

Upon examination the membrane presented the characteristic symptoms above described. Its outlines were entirely obliterated, so that it was difficult to recognize it at all. Its surface was dull (not shiny) and smooth, and seemed to be convex outward. Its color was a uniform dark red (venous) flesh color. The dividing line between the membrane and skin was not distinguishable. The adjacent skin was somewhat congested, though not much. The ear was dry and quite deaf. Noises, together with autophonia, were complained of.

Diagnosis.—Uncomplicated acute myringitis.

I ordered atropine solution (4 grs. to ounce) to be dropped into the ear, warm, every hour, till the pain ceased, and then three to five times a day.

The first application relieved the pain in a "*short time*," and it never returned. That night she slept well all night. The atropine was continued, but less frequently, as the ear improved. The membrane rapidly regained its natural appearance, and in less than ten days the patient was dismissed as well. The atropine must have done the work, as nothing else whatever was used in the treatment.

Case 2.—Mr. W——, æt. 35, a bar-tender, applied for treatment last Christmas, with the following history: Three days previously, he was aroused from a deep sleep in the latter part of night with pain in his ear, which grew rapidly worse. *Caustic* patent medicine was used, which "*burnt like fire*;" still the pain continued to grow worse. He had not slept a wink for three days, except a moment at a time, when he would hold his ear close to the hot stove. To use his own words, "I never had anything to get me down so completely and rapidly in my life as this pain." Deafness, heaviness or fullness, and noises in the ear were complained of.

The examination revealed considerable otorrhœa. When the ear was syringed, the skin bled quite freely. The membrane was somewhat covered with white epithelial stuff; in its centre a superficial loss of substance could be made out, in the bottom of which pulsations were visible. Other parts of the membrane were very red and seemed to be swollen.

The patient seemed to have a *fresh cold*, and for that reason I suspected inflammation in the drum; but the success of the treatment disproved the suspicion.

DIAGNOSIS.—Acute myringitis, aggravated by the use of caustics, which had evidently injured the skin and membrane, and had caused the discharge. As already stated, trouble in the drum was suspected, but the treatment would have to decide the doubt.

TREATMENT.—To begin with, I put a little atropine in the ear, and then dropped two or three drops of water in to dissolve it, and let the whole remain in the ear about ten minutes. The pain was entirely relieved in less time than that.

I prescribed atropine solution (4 grs. to ounce), with directions to use it as often as necessary, to keep down the pain. The patient returned in three days. He had not used the medicine, as the pain had not returned. The ear was better already, the discharge was less, and the membrane showed a disposition to heal, though the pulsations in the bottom of ulcer were still to be seen. After syringing the ear, I reapplied the atropine powder, as before. I directed the patient to use the medicine anyhow three times a day, whether he had pain or not. I did not see him for four days. New Year's night, after considerable dissipation, the pain returned in rather a mild form, but sufficient to bring the patient in next morning.

Had not used the medicine; had not even had the prescription filled. The appearance of the ear did not show evidences of a relapse; the discharge was still less, and the membrane seemed to be healing. I washed and treated the ear in the same way.

After this, the discharge soon ceased; the membrane healed very rapidly; the ulcers soon filled up and smoothed over. The hearing improved with the membrane.

At the end of three weeks the patient was so well he ceased to come. During that time there was made in all about six applications of atropine. I have no doubt but that he would have recovered in less than half that time if he had used the medicine as directed. The atropine was the only thing used, and it must have done the work.

There could have been no trouble in the drum, else the ear would not have recovered so easily. I am satisfied that the ulceration of the membrane and the discharge were produced by the caustic patent medicines.

Case 3.—Dr. E——, while attending the clinic, in Cincinnati, took a severe pain in one of his ears toward the latter part of the night. When I saw him the following day he was still suffering. The membrane was in the congestive stage (see lithograph) of acute myringitis. The marginal and malleus vessels were much injected, and there was a general diffused redness apparently in its substance. The membrane had not yet begun to swell. I diagnosed incipient acute myringitis, and prescribed the atropine solution, to be used in the usual way. The first application relieved the pain in a few minutes, and in two days the ear was well.

General Remarks.—It will be observed that in all these cases the severe pain began at night, suddenly, and in one ear; that the pain, severe at the start, was constant and rather disposed to increase than diminish; that it continued in all till the treatment was begun, lasting in one case six weeks, in another three days, and in the third only a few hours. They were all treated with atropine solution alone, and all recovered rapidly and completely. These facts certainly justify the general prognosis that, without treatment, the disease will continue indefinitely; with treatment, the relief is sudden and permanent, and the recovery rapid and complete.

The uniform and gratifying success of the atropine treatment impresses one with its certain effectiveness, which should be proof of its superiority over all other methods of treatment heretofore recommended by the authorities. It has always acted like a charm in my hands, and consequently I can recommend it to others with full confidence that it will prove to be all I claim for it in the treatment of acute myringitis.

I could refer to other cases, but I consider that the above are sufficient to illustrate the general description of the disease, given above, and to show the gratifying success of the treatment.

I am well aware that my account of acute myringitis differs very materially from the descriptions of others in several respects. *Troeltsch* speaks of otorrhœa as one of the regular symptoms, and also of perforation of the membrane as of frequent occurrence, and recommends strictly antiphlogistic treatment.

Gruber speaks of otorrhœa as one of the symptoms, and says that perforation of the membrane almost always takes place. He seems to describe under the head of acute myringitis what I shall treat of under the general head of otorrhœa (see below). His treatment is also antiphlogistic.

Myringitis Parasitica (myringo-mykosis).—This is acute inflammation of the membrane, supposed to be caused by a vegetable parasite of mushroom variety called aspergillus (Wreden). But little remains to be added here, as the characteristic peculiarities of the disease have already been described under *Otitis Parasitica* above. With respect to the membrane it may be said that if the parasites are allowed to remain in the ear, sooner or later they will cause a perforation of the membrane, and make their way into the cavity of the drum, from which it is more difficult to remove them, besides they are more dangerous there than in the meatus. There is no subjective symptom that discloses the presence of the parasites in the ear. They cause a peculiar white, lardy, tough secretion (non-purulent) in the ear, in which the microscope reveals their presence.

In the treatment there is only one indication: remove the parasites and prevent their reproduction. They should be syringed out, if possible; if that does not succeed, then the tough white secretion and epithelial scales must be carefully picked out with the forceps.

To kill those remaining, and to prevent their reproduction, anti-parasitical medicines must be used. Solutions of tannin, sugar of lead, and carbolic acid are the favorite remedies.

Very recently an attendant at the clinics of *Politzer* and *Gruber*, in Vienna, writes* that these gentlemen are now using pure alcohol in such cases, and upon their authority recommends it very highly as the most effectual remedy of all. The ear should be filled with the alcohol three times a day, always cleansing it first. After it is supposed the parasites are all destroyed, it should be continued once a day for several days, as a precautionary measure. These parasite affections of the ear are a discovery of the last few years, and it is claimed that they are quite common. Noises, pain, more or less deafness, and sometimes otorrhœa are the leading subjective symptoms of myringitis parasitica.

It is not known where the parasites come from, nor how they get into the ear. Neither is it definitely known whether their starting-point is the surface of the membrane or the adjacent parts of the meatus; most probably they begin in the former and extend to the latter.

CHRONIC MYRINGITIS.—It is very questionable whether there is such a disease as *spontaneous uncomplicated* chronic inflammation of the membrane. That condition of the membrane usually described under the head of chronic myringitis is very common indeed; but, according to my experience, it is always a complication of some other primary disease. It has already been seen how often and apparently how easy complications of the membrane take place in connection with the diseases of the external meatus, and particularly so in otitis diffusa; hereafter it will appear that complications of the membrane are still more common and much more serious in their nature in acute inflammations of the cavity of the drum (see Diseases of Drum below). All these secondary inflammations are characterized by points of circumscribed infiltration on its surface and probably in its substance, which are very prone to take on ulcerative action, ending very frequently in perforation of the membrane in one or more places. This condition of the membrane with these infiltrated points, which might be called incipient abscesses, is described by most of the authors as chronic myringitis. Being a secondary matter, it hardly merits an independent consideration; but nevertheless it is very interesting as showing the way in which

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*A. W. Calhoun, M. D., in Southern Med. Record for February, 1873.

ULCERATION AND PERFORATION of the membrane nearly always take place. An infiltrated point ulcerates in its centre, and the process goes on till it perforates the membrane. The first intimation the patient has of the fact is generally the whistling of the air through his ear when he coughs or blows his nose. This ulcerative process, like chronic myringitis, is also a secondary affection, a complication of some previous disease. I do not remember ever to have seen an idiopathic or spontaneous ulcer develop in a previously healthy membrane. Heretofore, in the consideration of otitis diffusa, I gave it, as my opinion, that the frequent ulceration and consequent perforation of the membrane is the result of the interruption of its proper nutrition by a previous disease in its associate parts, either external or internal. I am not able to explain its frequent occurrence satisfactorily in any other way. The anatomy justifies this explanation. The relations of the membrane are such that its nutrition can be very easily interfered with by inflammatory swelling either in the meatus or in the drum.

All these secondary affections of the membrane are accompanied with more or less otorrhœa. The degree of deafness depends upon the amount of swelling and the extent of destruction of the membrane by ulceration. The perforation may be very small—a mere point—or it may involve a quarter, half, or even the entire membrane.

The treatment must be directed specially to the primary diseases, and not to the secondary complications of the membrane, which need no particular treatment, as they will get well of themselves when their primary cause is removed.

The smaller perforations, and sometimes even large ones, cicatrize of themselves, particularly if the ear is treated soon after they have taken place. I never cauterize their margins to make them heal. That, in my judgment, is bad practice, to say the least.

But the treatment most appropriate in such complications of the membrane involves the general treatment of otorrhœa, which is a common symptom of the primary diseases and their complications. For all the details I must refer to the consideration of otorrhœa hereafter.

INVISIBLE PERFORATIONS OF MEMBRANE.—In extensive practice in otology occasionally a membrane is met with in which numerous perforations have taken place that are absolutely invisible upon inspection. The only way they can be proven is to inflate the ear through the catheter, and observe or listen to the escape of the air through the membrane. The whistling of the wind through these small holes is very characteristic, and sounds as though it was passing through in a dozen or more places. Under such circumstances I have had the wind pass clear through the otoscope and strike my own ear. I have never been able to see the perforated points afterward; hence I call them invisible perforations. The membrane is so white it seems to be almost bloodless; is thicker, and apparently softer and less elastic than natural. The handle of the malleus and cone of light are usually very dimly defined or almost totally obscured. This condition of the membrane mostly follows a catarrhal trouble in the drum that has run its course and disappeared, leaving the mucous membrane in something of a zeromatous condition. What the *pathological* condition of the membrane is, I am not able to say.

THE PROGNOSIS is very unfavorable indeed. I have never known a case of the kind to improve even the slightest in hearing. Deafness is about all that such patients complain of.

TREATMENT I do not recommend. I know nothing that promises even the slightest benefit. One case of the kind I remember having treated for some time by repeated inflations and amputation of the enlarged tonsils, but all to no purpose.

CALCAREOUS DEPOSITS in the membrane are quite common. According to the authorities these deposits form after the disappearance of a long-continued otorrhœa; hence the theory is that they are caused directly or indirectly by the otorrhœa. *Politzer* thinks that exudation from the vascular layers first takes place into the substance of the membrana propria, which gradually undergoes chalky metamorphosis. I have seen persons with quite extensive chalky deposits, who could not remember that they had ever had otorrhœa. This, however, does not prove that they did not have it in childhood. These deposits often take place in connection with chronic catarrh of the drum where there is no external otorrhœa whatever, so that I am disposed to think that that does not precede their formation in all instances.

Chalky deposits are found mostly in grown persons, particularly in those far advanced in years, though they sometimes occur in children. It would be naturally expected that calcification of the membrane would most frequently take place in persons of gouty diathesis, but that does not seem to be true in fact.

The process of calcareous deposit begins in the fibrous layer, and gradually increases until it involves the entire thickness of the membrane and may even project above its surface. (*Politzer.*) Small deposits, of course, would be confined to the fibrous layer.

The Pathology of the process is very obscure. The deposits consist of carbonate of lime. *Politzer* has discovered in one case the formation of true bone in connection with these deposits. They are very easily recognized on account of their pearly, sometimes slightly yellowish, white appearance. Their most usual form is semilunar, but they may have all kinds of shapes. They may occur in any part of the membrane, but their most usual situation is behind, before, or below the handle of the malleus, with the convex edge toward its margin. These deposits are frequently observed in membranes that have been partially destroyed by ulceration and perforation.

The degree of deafness produced by these calcareous deposits does not depend upon the extent of the deposit in the membrane so much as upon the *probable* deposit, that takes place at the same time, according to *Troeltsch*, around the foot of the stapes and in the membrane of the fenestra rotunda (see below). As has already been observed in *Anomalies in Health*, there may be very extensive lime deposit in the membrana tympani, without perceptibly interfering with the power of hearing. Such cases, however, are exceptions. The rule is that such persons are more or less deaf, depending, perhaps, mainly upon changes deeper seated.

THE PROGNOSIS, therefore, is, as a rule, decidedly unfavorable. Experience teaches that the probability is that the hearing of an ear with deposits of this kind in the membrane will grow gradually worse, certainly not get any better.

TREATMENT.—Calcification of the membrane is entirely beyond the reach of remedies. If any active disease can be discovered, that should be treated.

OPACIFICATION of the membrane takes place occasionally in different parts. There may be infiltration in the substance of the membrane, forming a more or less circumscribed white or yellowish opacity. This takes place usually in the posterior part, though sometimes in the anterior and lower part. The opacity usually accompanies or follows chronic inflammation of the drum, and is the result of a not well-understood pathological process. It is supposed that chalky transformation sometimes takes place in these infiltrations, producing what is called calcareous deposits (see above). Suppuration may occur in these infiltrated points, forming abscesses, though these are very rare in the membrane.

Politzer has particularly described what he calls "tendinous opacities" of the membrane. They consist of alternate *opaque* and *translucent* stripes, running in different directions through the membrane. The opaque stripes are thickened or hypertrophied parts of the membrane, while the translucent stripes are thinned or atrophied portions. It is a strange fact that alternate portions of the membrane should be hypertrophied and atrophied, the result of processes apparently directly opposite.

These striæ may occupy only a small portion or the larger part of the membrane. They are sometimes arranged in radiating form around the "umbo," and often accompany or follow chronic inflammation of the drum, like the infiltrated opacities.

A narrow white opaque stripe around the extreme margin of the membrane has been described by different authors, and has been compared to the *arcus senilis* of the cornea. (*Wilde aud Politzer.*) It, however, is not peculiar to old age, and is not constant in old people.

All these different opacities, even to a large extent, do not necessarily interfere with the hearing power, as they are not unfrequently seen in membranes with natural acuteness of hearing.

TREATMENT is unavailing, so far as the opacities are concerned.

IRREGULARITIES *in the membrane*, in consequence of disease, are quite common. When a large portion is destroyed by ulceration or sloughing, the remaining healthy portion may draw the handle of the malleus either forward or backward, as the case may be, and thus displace it; or, where adhesions have taken place between the membrane and the internal parts, the malleus handle may be drawn inward, so as to show an increased oblique position. When there is no perforation, these internal adhesions may draw the whole membrane inward; or when, from any cause, the air of the drum is exhausted, the external air presses it inward, making it unnaturally *concave* externally. On the other hand, when fluids accumulate in the cavity of the drum, they press it forcibly outward, making it unnaturally *convex* externally.

When perforations have healed, the cicatricial tissue is often less resisting than the healthy membrane, and consequently yields first to these internal and external influences, producing circumscribed concavities and convexities in the surface of the membrane. These elevations and depressions often have an unnatural color, as the cicatricial tissue may be more opaque (whiter) or more translucent (darker) than the healthy membrane. All these abnormal curvatures and conditions of the membrane must be studied with a great deal of care, in order to understand the full import of what has gone before and what may be expected to follow.

Again, the surface of the membrane is sometimes rendered uneven by the development of fungous granulations in points or in clusters over it. This condition of the membrane is always accompanied with otorrhœa (see below).

There is more or less deafness in all the above abnormal conditions of the membrane, the extent of which can never be told by simple inspection. In this respect the appearance of many membranes is wonderfully deceptive.

Noises are sometimes a distressing accompaniment of these conditions of the membrane.

Treatment.—Unfortunately these changes are nearly all permanent, so that treatment is useless. Whatever active disease may be still present should be treated. The fungous granulations must be destroyed with caustic or astringent applications, as will appear in the treatment of otorrhœa.

Hernial Protrusions in the membrane take place sometimes in consequence of partial perforation of its substance. For instance, an ulcer may eat through the external and middle layers of the membrane down to the internal or mucous layer; here, from some cause, the ulcerative process ceases: the mucous membrane, by any kind of pressure from within, as in inflation of the drum, or in the Valsalvian experiment, may be pressed through this opening in the outer layers in the form of a hernial sack, and is properly called *hernia* of the membrane. *Politzer* has described a case of the kind, in which he had an opportunity to make a post-mortem examination, and found that the facts harmonized with his theory of the matter before death.

A condition somewhat similar to this may occur in the external layer. If, from any cause, the internal and middle layers are broken, the pressure from within will cause the unbroken external layer to bulge outward into the meatus. *Troeltsch* has observed a case of the kind on the upper part of the membrane.

Treatment.—These hernial protrusions occur mostly as complications of affections of the tympanum, and the treatment should be directed to those primary diseases. If these have run their course and subsided, and the ulcerative process has ceased, no treatment is indicated.

General Remarks with Respect to the Membrane.—I have thus very briefly referred to the leading pathological changes that occur in the membrane. I have endeavored to indicate their nature, so far as that is understood in the present state of otological science, without going into *tediously* minute details. I have confined myself to practical things as much as possible, and, in doing that, I have avoided all I could, consistently, with a full knowledge of the importance of the subject, the purely theoretical matters. In this way I hope to have given my readers a better idea of the pathology of the diseases of the membrana tympani and the necessary therapeutics, than they would have received from a *wearisome* detail of the less important things. I can not impress the great importance and absolute necessity of studying healthy membranes at every opportunity too much upon every one, and, particularly, beginners who expect to interest themselves in otological affections. If they know what is *natural* in the membrane, it will not be difficult for them to understand what is *unnatural*, and, as a result, a correct diagnosis follows.

The power of hearing is the standard in all cases. Every ear that hears perfectly is said to be *physiological*, and every one that has not perfect hearing power, is said to be *pathological*. The dividing line between the two is not by any means well marked.

It has already been seen that extensive changes, apparently pathological, are not unfrequently found in physiological ears; on the other hand, ears with healthy membranes to all appearances, when tested, may prove to be quite deaf. The examination, therefore, can not be too rigid before an opinion is ventured. Without testing the hearing power it is impossible to tell whether an individual can hear or not. From this it is very easy to see how very difficult it is for a medical man to settle medico-legal or medico-military questions in cases of *feigned* deafness, where he can not rely upon what the parties tell him.

Movements of Membrane.—These, in a healthy condition, are limited; in fact, in some membranes they are not perceptible at all. Usually, however, when air is pressed into the drum by the Valsalvian experiment or by inflation, the parts, midway between the manubrium and the margin, are seen to swell up slightly into the meatus, and then, as soon as the atmospheric pressure is relaxed, they sink back again. These movements occur most uniformly in the posterior segment of the membrane, less frequently in the anterior portion, and occasionally below the end of the malleus handle. It will be remembered that there is an accumulation of the circular fibres around the margin of the membrane and somewhat so close about the manubrium, so that the central parts of the membrane between the handle and margin are thinnest, and, consequently, yield first to the pressure from within. This explains why the movements should be confined to these parts. The handle of the malleus and the parts adjacent move so little it can not be seen (*Politzer*). In these movements the cone of light varies according to the changes in the curvature of the membrane at that point. If the air in the drum is withdrawn somewhat by repeatedly swallowing with mouth and nose closed, instead of being pressed into it, of course these movements will be reversed—the corresponding points in the membrane move slightly inward.

The above may be called the *physiological* movements of the membrane, and whatever differs materially in character from them may be regarded as *pathological.*

Thinned or atrophied portions, of course, will show so much more perceptibly in varying the atmospheric pressure in the drum. If adhesions have taken place between the membrane and deeper parts, the movements will be irregular. If the membrane is thickened or hypertrophied, they may be imperceptible. If the entire membrane is atrophied, it falls, as it were, into folds in a state of quiet; but when air is forced into the drum, its whole surface will bulge far into the meatus and then collapse again upon relaxing the pressure. In such cases the manubrium usually moves with the membrane. Some of the authors call this condition *collapse* of the membrane; a better name would be *complete atrophy*. When the Eustachian tube is closed, permanently or temporarily, no movements are visible in the membrane.

All these abnormal movements are to be taken into consideration in prognosing in affections of the ear. They nearly always indicate deeper-seated troubles.

PULSATIONS IN THE MEMBRANE.—Formerly it was thought that pulsations were only visible where perforations had taken place. This idea, however, has proven to be incorrect. Now, it is well known that pulsations are sometimes visible in membranes not even ulcerated, much less perforated. They usually indicate a perforation, but may be seen in any considerably injected membrane, particularly if a little water or matter is lying upon it. From some portion of the fluid a bright reflection is often seen; the blood, in passing, changes the position of the fluid, and, as a consequence, the reflection moves. In this way the pulsations are rendered visible. To determine whether any perforation is present or not, it is only necessary to have the patient hold his mouth and blow, and thus force the air into the tympanum and through the perforation, if there be any. The patient is not always able to exert sufficient force in this way; to determine the matter, in that case, the ear must be regularly inflated. The methods will be given hereafter in detail.

Paracentesis of Membrane.—This is an old operation, recently revived, and consists in simply puncturing the membrane with a sharp instrument. At first it was performed on animals and then on men. *Astley Cooper* was among the first to make it on a human being, about the first of this century, at which time the operation became somewhat epidemic among physicians in England and on the continent of Europe. It, however, was short-lived, being soon given up as worthless, and forgotten. Within the last ten years, *Gruber*, of Vienna, has brought the operation into prominence again, by recommending the excision of a piece of the membrane. This has led to the revival of the whole subject, and specialists all over Europe have again taken the matter up, and are now doing the operation extensively. Most of them praise, while some condemn it. Its general advisability is by no means *settled*, and there seems to be great danger of carrying it to the last extreme by recommending the puncture of the membrane in nearly all its affections, both primary and secondary.

The following may be given as the most reliable or *manifest indications* for paracentesis of the membrane:

1. Abscess of the membrane. This, however, is very *rare*, as already stated, but when it does occur it should be punctured early. Of course the puncture must be made through the seat of the abscess.

2. Blisters or vesicles on the surface of the membrane should be punctured. The nature of these vesicles is not well understood. They seem to be raised

epithelium, by a collection of serum from some cause beneath it. In this respect they resemble common blisters. These are likewise rare, but when they do occur, they should be punctured, so as to allow the serum to escape. *Troeltsch* mentions an interesting case of this kind, in which he opened quite a large vesicle on the membrane, which gave instant relief from severe suffering and serious symptoms.

3. In all considerable collections of fluid, of whatever kind, in the cavity of the drum, puncture of the membrane is particularly indicated, as the best means of preventing its serious injury by more or less extensive rupture. An incised wound in any tissue is far preferable to a rupture.

These collections in the drum are indicated by partial or total bulging of the membrane outward, together with other evidences, all of which will be considered in detail in Diseases of the Drum below. To evacuate these fluids most effectually, the puncture should be made at the posterior inferior part of the membrane, as that corresponds to the most dependent part of the drum cavity. If only a small portion of the membrane bulges outward, the incision should be made at that point wherever it may be.

4. Paracentesis is indicated in cases of unnatural tension of the membrane, produced by its being forced inward by the external atmosphere. This condition occurs only when the equilibrium of the external air and that of the drum is interfered with by disease, as in obstruction or actual closure of the Eustachian tube. The condition is recognized by the great concavity of the membrane externally, as indicated by the great obliquity of the handle of the malleus, and the marked

prominence of the short process and anterior and posterior folds in its upper margin. (*Gruber.*)

In addition to these appearances in the membrane, a close examination of the tube must be made in order to discover whether it is obstructed or closed. In case it is, the diagnosis of unnatural tension is established. If the equilibrium between the air without and within the drum can not be restored through the tube in the way to be described hereafter, then paracentesis of the membrane should be made so that air can enter the drum cavity from the meatus. For this purpose the puncture may be made in any part of the membrane, but by choice in the posterior lower portion. It should always be made at that point, if there is no particular reason for its being made elsewhere, as in abscess, vesicles, or circumscribed bulging of the membrane.

The extent of the incision must be regulated according to circumstances ; as a rule, one to two lines is large enough. The cut may be made in any direction. As soon as air enters the drum cavity, all the symptoms, such as more or less deafness, noises, and possibly dizziness, dependent upon the unnatural tension of the membrane, are at once relieved. But the great trouble is that in a short time—twenty-four to forty-eight hours—the puncture closes, and all the old symptoms return, and the operation has to be renewed. Were it possible to keep the incision open as long as it might be desired, paracentesis of the membrane would be a great success. Thus far all efforts to prevent the healing of the punctures have been sad failures. All kinds of foreign substances have been introduced into the artificial openings, and have remained there for indefinite periods, and still, as soon as they are removed, the perforations close. Regular inflations of the drum will not prevent their healing, neither will the repeated passing of a probe through the incisions prevent their closure, except so long as the process is continued.

Politzer, a short time since, introduced an eyelet of gutta-percha into a puncture in the membrane, and allowed it to heal up that way, in the hope that it would remain there permanently, and that the air could pass to and fro through an opening in the eyelet. But in a few days the foreign substance fell out and the membrane healed up.

So then, in general terms, it may be said that, in the present state of our knowledge on the subject, it is impossible to perpetuate an opening made by a punctured wound of the membrane. This fact *spoils* nearly all the good effects of simple paracentesis, except where only a temporary opening is required, as in collections of fluid in the drum cavity.

The operation is but momentarily painful, and no serious inflammatory reaction follows it. According to *Gruber*, patients often go immediately to their work. No particular after-treatment is necessary.

The operation, of course, must be made under perfect illumination of the meatus in the usual way, so that the operator can see exactly what he is doing. To try to puncture the membrane in the dark would be *criminal* in the highest degree.

Numerous instruments have been devised for the operation, but any long very narrow knife will answer the purpose very well.

A large speculum is introduced into the meatus, and then the knife is passed in, and its point made to puncture the membrane at the desired place, and the incision is finished as it is withdrawn. The extent of hemorrhage amounts only to a few drops of blood, which should be either washed out or removed with probe and cotton.

In making this operation the knife should never be allowed to pass in far enough to reach the inner wall of the drum, as it might do some injury there.

Very recently *Gruber* has recommended *numerous* parallel incisions to be made at the same time in cases of unnatural or abnormal tension of the membrane. The incisions range in number from two to six or seven, part to be made in front and part behind the handle of the malleus. He reports two cases of the kind, neither of which is satisfactory in result, so far as I can judge. In fact, I do not consider that he gives any good reason why the numerous incisions should accomplish more than the single one. He *claims* that the cicatrixes in some way reduce the tension of the membrane, and, consequently, it is in a better vibrating condition after the operation than before it.

The above operation, which consists in simply puncturing the membrane in one or more places, is technically called *myringotomy* in contradistinction to another method of puncturing it, which is called *myringectomy*, and consists in excising a piece of the membrane at any desired point. (*Gruber.*)

According to this author the indications for this latter operation are about as follows:

1. In obliteration or permanent obstruction of the Eustachian tube; 2. In a high degree of thickening of the membrana tympani, with great difficulty of hearing; 3. In relaxation of the membrane; 4. In a high degree of ossification of the membrane, where there is considerable deafness.

It will be observed that, in these several conditions in which *Gruber* thinks that myringectomy is particularly indicated, the membrane is physically so changed that it receives sonorous vibrations in a very imperfect way; hence the usually persistent deafness and more or less confusion of sounds in such conditions.

In order to afford the greatest possible relief in such cases, there must be an artificial persistent opening made in the membrane, through which the sonorous vibrations can enter the drum cavity, and impinge directly upon the membranes of the fenestra ovalis and fenestra rotunda, and through these be transmitted onto the labyrinth. To accomplish this purpose, myringectomy has been proposed and has been partially successful. It is very easy to understand that when a piece of the membrane is cut away entirely, the opening is much less likely to close than when a simple puncture is made. *Gruber* found, however, that the loss of substance was very gradually replaced by cicatricial tissue. Some of the perforations remained open from six to eight months, and in one of his cases for more than three years. The rule is that they close in a few months. Of course the larger the excised portion, the less likely it is to cicatrize. When cicatrization occurs, the membrane is not in the same condition as before the operation. The cicatrixes are always thinner than the membrane, and consequently receive sonorous vibrations more perfectly than the surrounding stiff membrane. In this respect there is an improvement after closure of the perforations.

The operation may be made with a long very narrow knife, as in simple puncture. The excision may be made from any part of the membrane; but when it is optional with the operator, the posterior lower portion is to be selected, as an opening is less disposed to close at that point (*Gruber*), and besides, the membrane is more easily reached there.

The proper point being selected, the knife is entered below and carried upward in a circular direction, so as to include a sufficiently large portion, and is brought back to *near* the starting-point. The excised piece is left hanging by a very small tag or bridge, and should be removed with delicate forceps. This precaution is taken to prevent the excised piece from slipping into the drum, where it might cause trouble.

The operation is about as free from danger, according to *Gruber*, as simple puncture. Only a few drops of blood escape.

The after-treatment must be according to general indications. Thus far all efforts to keep the opening from closing have been fruitless, just as in simple puncture. As would be expected, the cicatrizing process is slower where there is a loss of substance.

This operation is not yet fixed upon a firm foundation. Before it is proposed, all other means of treatment should be exhausted. Its theory is splendid, but so far the results are not very flattering. There is so frequently a diseased condition of the membranes of the fenestra ovalis and rotunda at the same time, when the changes in the membrana tympani show an indication for the operation, that the amount of benefit to be expected from it is always very doubtful. Further experience will have to settle the merits of myringectomy.

TENOTOMY OF TENSOR TYMPANI MUSCLE.—As this may be regarded as an operation on the membrana tympani, it belongs properly here. I must anticipate the anatomy of the tensor muscle sufficiently to say that its tendon passes obliquely across the upper part of the drum cavity from its anterior wall, and is inserted on the inner surface of the handle of the malleus, and, according to *Gruber*, on its anterior edge just below the short process. Consequently, when the muscle contracts, it draws the manubrium inward, a little forward, and slightly rotates it about its long axis. This may be regarded as the effect of the physiological contraction of the muscle. Its spasmodic or unnatural contraction, in consequence of disease, would have the same effect, but in a greater degree. *Politzer* first described the pathological contraction of this muscle as "secondary retraction of the tendon of the tensor tympani." It may occur as the result of inflammation and thickening of the mucous membrane of the drum, but usually it takes place as the result of obstruction or closure of the Eustachian tube. As soon as that occurs, the air is absorbed from the drum cavity, the membrane is pressed forcibly inward by the external atmosphere, and consequently the tendon is considerably relaxed. But muscles, in general, when they are unnaturally relaxed for a considerable time, are *disposed* to undergo permanent contraction. The tensor tympani is no exception to this rule, and sooner or later it contracts permanently, and when the permeability of the Eustachian tube is re-established, it holds the membrane in its unnatural position. To relieve this great tension, and restore the membrane to its normal position, tenotomy of the tensor tympani muscle is proposed.

Hyrtl first spoke of its probable good effects incidentally in some of his anatomical descriptions.

Politzer proved such a pathological condition of the muscle by post-mortem examination. *Troeltsch* afterward spoke approvingly of the operation, and recently *Weber*, of Germany, has carried these suggestions into effect, and has already operated on several cases. In the last few months, *Gruber* reports an operation of the kind in one case.

It is by no means easy to diagnose a permanent contraction of the tensor tympani; in fact, a good deal has to be guess-work. The most prominent symptoms are about these: The membrane is unnaturally concave externally; the manubrium has an oblique position, as if drawn inward; the anterior and posterior folds are well marked and prominent; the short process is prominent, and points too much forward; the handle of the malleus is broader than is natural. *Gruber* lays special stress upon the last two symptoms, and claims that the rotating effect of the muscle turns the short process forward and the posterior flat surface of the manubrium outward, making it appear broader. When the drum is inflated, the membrane either retains its position or moves outward slightly, and falls immediately back as soon as the blowing ceases.

The subjective symptoms are deafness, noises in the ears of a distressing character, with swimming of the head, vertigo, indisposition for mental labor, and sometimes impaired memory. These latter symptoms probably result from pressure upon the labyrinth through the chain of little bones.

It will be observed that many of these symptoms are common to other diseases, so that all other means of treatment should be exhausted before tenotomy is proposed. That should be a kind of last resort.

Tenotomy of the tensor tympani is not a difficult operation to make. Only one cutting instrument is necessary, and that a very short narrow knife, with a long slender shank for a handle. *Gruber* fastens the knife in a separate handle, so that they stand at right angles with each other. The extreme point of the knife should be bent upon the flat, so that it can be made to hug closely the inner surface of the handle of the malleus. If the knife is *double-edged*, it will save the necessity of two, one for each ear.

A large speculum is introduced into the ear, and the meatus is *well illuminated* in the ordinary way. The patient's head being held by an assistant, the operator passes the knife in, and punctures the membrane close in front of the handle and *just* below the short process, and makes its point pass horizontally backward as closely as possible to the inner surface of the malleus handle, until the point is supposed to reach its posterior edge. In this position the knife is carried downward about one and a half lines, making an incision of that length in the membrane, and then it is withdrawn. In this maneuvre the tendon is divided. At the very instant it is cut, it gives an "*audible snap*" (*Gruber*), which is one of the proofs of the success of the operation. In favorable cases the membrane soon returns to its natural position, and all the symptoms dependent upon pressure in the labyrinth are either cured or much relieved.

The pain is comparatively slight, and, according to *Gruber*, chloroform is not necessary.

The after-treatment is simple: the drum should be inflated repeatedly, so as to force the membrane back to its normal position, and to clear out any blood or secretions from the drum cavity. In a few days, the incision in the membrane will close.

The possible accidents that might occur during the operation, are the puncture of the carotid and membranes of the round and oval windows leading to the labyrinth. Of course such accidents must be scrupulously avoided, and, if the knife is held closely to the malleus handle, as above described, there is no danger of either of these accidents.

The great uncertainty in determining whether the deeper-seated essential parts of the ear are sound or not, makes it very difficult to say beforehand whether tenotomy of the tensor tympani will be beneficial or not.

Many of these undetermined questions will have to be settled by further experience.

The *theory* of the operation is very good, but the future will have to show its practical results, or prove the inapplicability of the operation.

TYMPANUM (Drum, Cavitas tympani).—This is usually spoken of as the *middle ear*, which implies its central location with respect to the outer and internal parts of the ear. It is hardly correct to call the drum the *middle ear*, as it is not an ear, but only a part of an ear. The same remark might be made in regard to the external and internal parts, which are also called *external* and *internal ear.*

The drum, in a pathological sense, is the most important part of the whole, as it is the seat of a considerable majority of all aural diseases ; at least that is the result of my observation. Hence it would be expected that the cause of deafness, in most cases, would be found in the different parts constituting the drum.

ANATOMY OF TYMPANUM.—The drum is a small irregular cavity situated just internal to the membrana tympani. The membrane forms the greater portion of the outer wall of the drum : it is often called the head of the drum, because it is stretched, as it were, over the drum cavity, as the parchment is stretched over the end of an ordinary drum.

The internal wall of the drum cavity is a bony partition between it and the labyrinth. In the posterior portion of this wall are two openings: the *fenestra ovalis*, leading into a deeper-seated cavity, the vestibule; and the *fenestra rotunda*, likewise leading into a deeper cavity, the cochlea. In front of these two openings is a round prominence in the wall, called the *promontory*, which is about opposite the centre of the membrane. This prominence is produced by a turn of the cochlea, which is situated just within the bone at that point.

The distance between the promontory and the most convex point on the internal surface of the membrane is about one line. Hence, in puncturing the membrane and in tenotomy of tensor tympani muscle, the point of the knife can not pass far into the cavity before it strikes the opposite wall, the injury of which should always be avoided.

In the anterior wall is to be found the tympanic opening of the Eustachian tube, looking in a direction backward, parallel with the plane of the membrane. This opening is a little above the floor of the drum, and a consequence of this fact is that a small portion of any fluid secretion remains in the bottom of the cavity. Above the mouth of the tube the tendon of the tensor tympani muscle enters the drum cavity and passes obliquely outward, to be inserted on the handle of the malleus just below the short process, as already stated in considering the tenotomy of the muscle.

The Glaserian fissure opens into the drum through its anterior wall, and gives passage to a number of structures to and from the cavity.

The lower wall, or floor of the drum, varies very much in different persons. Sometimes it has considerable thickness; then again it is so thin that it is almost transparent. This fact is so much the more interesting, in a practical way, because the internal jugular vein lies just beneath the surface of the bone. In some animals, according to *Troeltsch*, there is no bony tissue between this vein and the floor of the drum cavity. There is a small perforation in this wall for the passage of the tympanic nerve. From all of which it is not difficult to understand that a caries of the floor of the drum might involve the jugular vein and the important surrounding parts. *Troeltsch* lays particular stress upon such a possible complication of diseases of the drum, and says, in substance, that the lower wall is most subject to affections of the bone, for the reason that all the morbid secretions of the drum constantly collect and stand there, and are liable to induce disease of the bone.

The upper wall, or roof, varies in thickness similarly to the lower wall. The bone substance is often somewhat soft and very porous, and contains a large number of perforations for the transmission of blood vessels from the cavity of the cranium to the drum, mostly branches from the middle meningeal artery.

The petro-squamosal fissure passes through the upper wall of the drum, and remains somewhat open for some time after birth, but closes in after years.

There is, therefore, a much closer connection between the *dura mater* and the *mucous membrane* of the tympanum in early infancy than in adults. For this reason inflammations in the drums of children are much more dangerous to life than in grown persons. According to *Troeltsch*, a kind of atrophy of the bone tissue sometimes takes place, so that the dura mater and mucous membrane come together. In that case, it is easy to understand how an inflammation of the drum could extend to the meninges of the brain. Then, again, caries of this bone occurs occasionally, in which case there is great danger of involvement of the brain or its membranes.

These close anatomical relations between the cranium and the drum show very plainly that diseases of the tympanum are dangerous to life, particularly so in children. Cases are common enough where a person with, for instance, tympanic otorrhœa is suddenly attacked with brain symptoms of the severest nature and in a short time is dead. The explanation is that the ear trouble has extended to the brain, most likely through the upper wall.

The posterior wall is characterized mainly by one large irregular opening or several small ones that lead into the irregular cellular cavity of the mastoid process, commonly called the *mastoid cells*. On the inner part of the posterior wall is seen a small hollow bony tubercle, *eminentia pyramidalis*, projecting into the tympanic cavity, from the apex of which the tendon of the *stapedius muscle* emerges, and, running forward, is attached to the neck of the stapes.

On the upper outer part, near the junction of the posterior with the external wall, is a small foramen for the transmission of the *chorda tympani* nerve.

The facial nerve bears a very important relation to the cavity of the tympanum. Beginning at the stylo-mastoid foramen, it passes upward behind the tympanic cavity in close proximity to the posterior wall; when it reaches a point corresponding to the upper internal part of the tympanum, it turns and runs horizontally forward for a distance, and suddenly turns again and passes inward toward the meatus auditorius internus, through which it reaches the brain in connection with the auditory nerve. In its course through the petrous bone the facial nerve runs along the upper margin of the inner wall, so close to the cavity of the tympanum that its position is marked by a small ridge in the surface of the bone. The nerve in this position is separated from the mucous membrane only by a thin porous bony layer, which, according to *Troeltsch*, is often defective in places and may be even wanting entirely. Under such circumstances the nerve and mucous membrane are in immediate contact. Hence, diseases of the drum may extend to the nerve trunk, and in practice it is found that the facial nerve is occasionally involved in tympanic affections, as is indicated by partial or complete paralysis of the corresponding side of the face. The anatomy explains the cause and nature of such a symptom in connection with diseases of the drum.

The canal through which the facial nerve passes, is called the *Aqueductus Fallopii.*

The body of one of the semicircular canals (to be described hereafter) lies very close to the cavity of the drum at the upper posterior part of its internal wall, and is separated from it only by a thin plate of bone. When this is perforated by caries, the suppurative process extends into the labyrinth and thence through the meatus auditorius internus to the meninges of the brain, and of course proves fatal. *Troeltsch* says a number of such cases have been observed.

The internal carotid artery passes up through the petrous bone close in front of and internal to the anterior portion of the tympanum. The artery is separated from the drum only by a thin lamella of bone, which is cribriform in the young subject and often absorbed in old persons (*Gray*). The close proximity of the artery makes it possible for it to be injured or perforated by caries of that part of the drum wall.

The intervening lamella, besides being thin and porous, is perforated for the transmission of blood vessels and nerves. This fact makes the involvement of the artery easier. According to *Troeltsch*, caries at this point not unfrequently takes place and leads to perforation, occasionally, of the arterial wall, with fatal hemorrhage.

Ossicula Auditus.—There is a chain of little bones across the cavity of the tympanum, beginning with the handle of the malleus in the membrane and ending with the foot of the stapes in the fenestra ovalis (see Fig. 13). This chain is composed of three little bones (ossicula), each one of which bears the name of the object it most resembles; hence the bones are named respectively malleus, incus, and stapes.

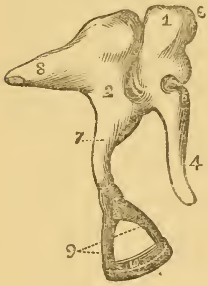

Fig. 13.

The Malleus (hammer) [see Fig. 13] has a head, neck, handle or manubrium, and two processes—the processus gracilis and processus brevis (long and short processes).

The head of the malleus is the larger upper part of the bone, and, in its natural position, it is placed above the upper margin of the membrane, and is attached to the bony portion of the outer wall of the drum by several ligaments, the chief one of which is the *suspensory ligament*, which extends from the upper extremity of the head to the bone above, and, as it were, suspends the malleus from the roof of the tympanum.

The neck is the constricted part below the head and

Fig. 13.—Ossicula auditus. 1. Malleus; 2. Incus; 3. Stapes; 4. Manubrium (handle); 5. Short process of malleus; 6. Head; 7. Long (descending) process of incus; 8. Short (horizontal) process; 9. Crura of stapes; 10. Foot of stapes.

corresponds to the upper margin of the membrana tympani.

The manubrium (handle) [see Fig. 13] is a continuation of the neck downward, and terminates near the centre of the membrane in a flattened extremity (see Membrana Tympani above). Its upper end is thickest, and its body tapers gradually toward the lower end. It resembles a handle, but is not exactly round. It has an inner and outer edge, and an anterior and posterior surface. In shortening or spasm of the tensor tympani this latter surface is turned outward, making the malleus handle unnaturally broad. This, it will be remembered, is one of the diagnostic symptoms of contraction of the tensor tympani, and at the same time an indication for tenotomy of the muscle (see above). As already stated, the body of the manubrium is imbedded in the substance of the membrana propria (see Membrana Tympani). The head and neck of the malleus make an obtuse angle with the handle, the opening of which is turned toward the cavity of the drum.

The short process is a small round tubercle, springing from the junction of the neck with the handle on the outer side, and projects into the external meatus at its upper margin. In a healthy membrane its position is indicated by a small round white spot (see Membrane). The long process (processus gracilis or longus), now considered a ligament, springs from the anterior part of the neck, and runs forward to the Glaserian fissure, and gives attachment to the anterior ligament of the malleus. Until very recently this ligament has been described as the laxator tympani muscle; the most recent authors regard it as a ligament. It attaches the long process in and about the Glaserian fissure. This is the strongest of all the ligaments of the malleus. According to *Gruber* the long process is *bony* in early life, but afterward degenerates into a band of connective or ligamentous tissue; hence it should be regarded as a ligament.

The head of the hammer has an articulating surface on its posterior aspect, supplied with cartilage and synovial membrane, so as to form a perfect joint with the second bone of the chain of ossicula.

THE INCUS (anvil) [see Fig. 13] is the second bone of the chain, and is divided for convenience into three parts—body, short process, long process. The incus, as a whole, resembles somewhat a bicuspid tooth with its fangs widely separated.

The body lies just behind the head of the malleus, and, consequently, just above the upper margin of the membrane. It has a quadrilateral shape, and is slightly compressed laterally. It has an articulating surface on its anterior aspect, corresponding in size to that of the head of the malleus, likewise supplied with cartilage and synovial membrane. In the articulation of the two bones these two surfaces come together and form a true joint, which allows *very limited* motion of the bones upon each other. The body of the incus has no ligamentous attachment to the wall of the tympanum.

The short process (see Fig. 13) is conical in shape, and runs horizontally backward toward the opening, leading into mastoid cells, in the posterior wall, to which its extremity is attached, some say, by ligament, and others, by a kind of joint arrangement.

The long process (see Fig. 13) runs perpendicularly downward behind, but parallel with the handle of the malleus, into the cavity of the tympanum. It can be seen occasionally through an unnaturally transparent membrane, as a small white line behind the manubrium. This process toward its lower extremity bends slightly inward, and its apex has a small articulating surface foi articulation with the stapes. The lower extremity of the long process is the so-called *os orbiculare*, or *lenticulare*. It was formerly described as an independent bone, and incorrectly so, as it is a part of the incus—apophysis of that bone, according to *Gruber*.

THE STAPES (stirrup) [see Fig. 13] is the third and last bone of the chain, and has a head, neck, and foot-piece, or base, with two crura.

The head is very small, and has a concave articulating surface, corresponding to that of the end of the long process of incus. The articulation between the two bones is in the form of a true joint.

The neck is a constricted part of the bone below the head, from which the two crura (see Fig. 13) diverge in the form of a stirrup, and unite with the foot-piece on opposite sides.

The base (foot-piece) [see Fig. 13] is a thin oval plate of bone that fits in the fenestra ovalis, but does not quite fill it up. The deficiency is made up by a circular ligament that unites the edge of the foot of the stapes with the margin of the fenestra ovalis, and is designated as the ligamentum obturatorium (annular ligament).

The stapes, as a whole, stands about at a right angle with the long process of the incus.

The obturator ligament around the foot of the stapes is strengthened internally by the periosteum of the vestibule, and externally by the lining membrane of the drum cavity.

The fenestra rotunda is filled up with a fibrous membrane, which is likewise strengthened by periosteum internally and by lining membrane of drum externally. This membrane is frequently called *membrana tympani secunda*, as it is supposed to vibrate like the membrana tympani, in performing its physiological function.

THE CHORDA TYMPANI NERVE comes off from the facial before it emerges from the temporal bone, and enters the tympanum behind, through a foramen already described, and runs horizontally forward across the upper margin of the membrane, between the manubrium and the descending process of the incus, to the Glaserian fissure, through which it passes out from the cavity of the drum. In the back part it runs along the lower margin of the posterior pocket, but in front it rises above the lower margin of the anterior pocket. After it emerges from the tympanum it runs forward to the submaxillary gland, and is connected directly with the gustatory nerve. Its physiological function is something of a mystery, but it certainly has nothing to do with the sense of hearing. Its excitement by electricity sometimes produces a peculiar taste in the tongue, as shown by a German experimenter.

The whole cavity of the tympanum, together with all the structures it contains, is lined with mucous membrane, which is a continuation of the mucous membrane from the throat through the Eustachian tube. In the drum it has a double function. It is a mucous membrane and at the same time a periosteum. This fact shows how an inflammatory disease in the tympanum may extend to the surrounding bone, and produce caries and endanger life.

MASTOID CELLS.—In the body of the mastoid process are numerous irregular cavities, some large and some small, communicating with each other. These are the mastoid cells, into which large and small irregular foramina in the posterior wall of the tympanum lead, as already stated. The mucous membrane of the drum extends into and lines these cells, where it acts also as periosteum.

The bone between the mastoid cells and the brain is sometimes very thin, and may be even defective in points, so that the mucous membrane and dura mater may come in contact. Besides this close relation of the membranes, the bone is perforated by numerous foramina for the passage of arteries and veins to and from the cavity of the cranium, making a direct connection between the membranes of the brain and the mucous membrane of the mastoid cells. Hence the danger from extension of disease of the latter to the meninges and the possibility of forcing air into the cranial cavity by too *forcibly* inflating the drum.

The external plate of the mastoid process is likewise thin, but softer and more porous than the internal, and is also perforated numerously for the passage of blood vessels between the skin externally and the mucous membrane of the cells, and through them communication is established between the skin and the meninges of the brain. It is well to remember this fact when it is desirable to deplete the deeper-seated parts by local blood-letting, as in affections of the meninges and the mucous membrane of drum and mastoid cells. In such cases the blood should be taken from the surface or region of the mastoid process. For the same reason, counter-irritation, when it is thought advisable in deep-seated troubles, should be made over the mastoid process.

The physiological use of the mastoid cells is not known. They are *supposed* to be a kind of atmospheric reservoir for some unknown purpose.

The Eustachian Tube is the ventilation apparatus for the tympanum or drum. It is a tube leading from the throat into the cavity of the drum, through which air passes easily into that cavity, and thus an equilibrium in atmospheric pressure inside and outside is secured, which is an essential condition for perfect hearing.

The tube is about one and a half inches long. It begins in the upper and outer wall of the pharynx, just above the level of the floor of the nose, and a little back of the soft palate, and runs outward, upward, and backward (or, beginning at the drum, its direction is inward, downward, and forward to the throat), and terminates in the upper part of the anterior wall of the tympanum, as stated above. The opening in the throat is called the ostium pharyngeum, and the tympanic end the ostium tympanicum. The size and form of its calibre is well shown by the accompanying cut (see Fig. 14), from which it will be seen that each extremity is trumpet-shaped. The general calibre is not round, but oval. The outer third of the tube is bony, its walls being continuous with the anterior wall of the tympanum; the internal or pharyngeal two-thirds are membrano-cartilaginous. The calibre of the tube, beginning at the tympanum, gradually

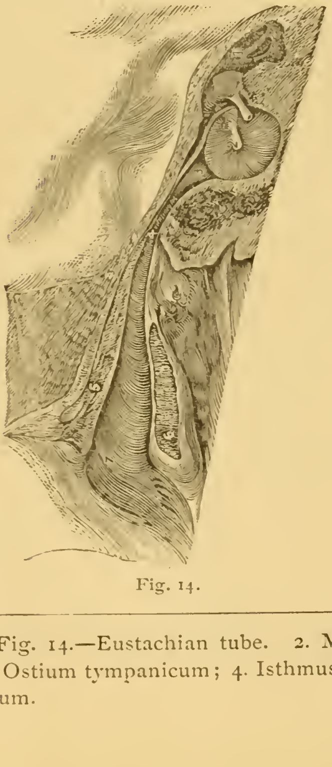

Fig. 14.

Fig. 14.—Eustachian tube. 2. Membrana tympani and manubrium; 3. Ostium tympanicum; 4. Isthmus; 5, 6. Cartilage; 7. Ostium pharyngeum.

narrows more and more through the entire extent of the bony part. Beginning at the pharynx, the tube likewise narrows more and more through the membrano-cartilaginous part. Where the two parts join, the tube is the smallest, and is about the size of a crow-quill. The narrowest point is called *isthmus.*

The tube is not straight, but slightly bent upon itself at the point of junction of the bony with the membrano-cartilaginous part, so that the concavity looks downward. The arrangement of the cartilage in the inner two-thirds is peculiar, and requires a minuter description.

The cartilage unites with the bony part by its outer margin, and is attached to the base of the skull by an intervening mass of fibro-cartilaginous tissue, formerly supposed to be simple connective tissue, but now known to partake more or less of the nature of the tubular cartilage, with which it is closely connected. The cartilage forms over half of the circumference of the tube in adults, and embraces or constitutes its posterior and upper walls. Its inner surface, with respect to the tube, is concave; its upper anterior edge is flexed upon itself sharply, so as to terminate in a blunt hook-like margin, beneath which something of a permanent cavity is formed, which corresponds to the upper anterior portion of the tube. Beneath this cartilaginous hook, the membranous part of the tube begins and runs downward so as to fill up the gap between the opposite edges of the cartilage, thus completing the tube. The membrane therefore embraces or forms less than half of the circumference of the tube in its anterior and lower walls. Like the cartilage, the membrane joins, by its outer margin, the inner extremity of the bony part.

Because the inner two-thirds of the tube is formed of membrane and cartilage, that is called the *membrano-cartilaginous* part.

The pharyngeal orifice of the tube projects slightly into the pharynx, particularly the posterior lip, which is cartilaginous, and remains open in a natural condition. The middle portion of the membrano-cartilaginous tube, in a state of rest, is closed; that is, its opposite walls lie in contact, or nearly so, giving the calibre a slit-like appearance in transverse sections. In the outer third of the membrano-cartilaginous tube, *Rüdinger* has described a small cavity, filled constantly with air, beneath the hook of the cartilage. Others confirm his description, as to the presence of the cavity, but deny that it is bounded by valvular folds in the lining membrane, as he thought. The bony part of the tube is always open in health. The mucous membrane of the throat is continued into the tube and lines its entire surface, and passes through it into and lines both the drum cavity and the mastoid cells, as above stated.

About the mouth of the tube, and in its pharyngeal extremity, the mucous membrane is thick and somewhat corrugated, and contains numerous mucous glands. As it ascends into the tube, it becomes thinner and more delicate, and the glands less and less numerous. In the bony part of the tube, it has a double function : is at the same time mucous membrane and periosteum, just as in the cavities of the tympanum and mastoid cells. The mucous membrane in these cavities is extremely thin and delicate, and has lost many of the characteristics of a mucous membrane, but is well supplied with blood vessels and nerves.

The physiological purposes of the tube are twofold : 1. It is a ventilation tube for the drum ; 2. It is a tube or means of exit for all kinds of fluid collections in the drum. It will be remembered that the tympanic orifice is not on a level with the floor, but is in the upper part of the anterior wall of the drum cavity, so that it can not completely drain that cavity while the body is erect. So, likewise, is the opening into the mastoid cells situated in the upper part of the posterior wall. The two openings are opposite, so that, if the axis of the bony part of the tube is prolonged, it will strike in or near the mastoid opening. Consequently, in inflating the drum, the stream of air does not strike *squarely* against the membrana tympani.

THE MIDDLE PART OF EAR IN INFANTS.—The above anatomical descriptions apply to grown persons. The same parts, in infants, differ in their description in several particulars, to some of which I wish to refer briefly. The pharyngeal end of Eustachian tube does not project into the pharynx in the child as in the adult, and its mouth is closed or nearly so. Its opposite lips lie so closely together, that it is sometimes difficult to find the opening in post mortems of children (*Troeltsch*). The mucous membrane in the tube is more corrugated, and consequently the tube is more distensible. The cartilage is narrower and smaller, and forms less than half its circumference; the membrane, on the contrary, more than half. This is another reason why the tube should be more distensible in the child. In its narrowest point, the isthmus, the tube is relatively wider; so, also, is the tympanic orifice. As a whole, it is proportionately shorter, straighter, and its direction more horizontal. Many of these differences result from an imperfectly developed tubal cartilage in the child.

The tympanum, in the adult, is a cavity that, in health, is constantly filled with air. Before birth, no air can get into this cavity. "Nature abhors a vacuum," and, to prevent its formation, the tympanic space, in fœtal life, is filled up with what *Troeltsch* calls a

Mucous Cushion, which is, or seems to be, a puffy, swollen, or soft velvety condition of the mucous membrane. Formerly, anatomists uniformly stated that, previous to birth, the tympanum is filled with mucous, which, according to the author just referred to, is a mistake, as no free mucous is to be found in the drum cavity of the fœtus or newly-born.

This mucous cushion develops mainly from the inner wall of the tympanum and extends across the cavity, and presses against the inner surface of the membrana tympani, so as to support it from within, which is certainly a wise provision of nature for its protection. Immediately after birth, upon the entrance of air into the drum, this mucous cushion disappears, and it yet remains to be seen whether this peculiar structure leads to any peculiar pathological conditions in the drums of infants.

The upper bony wall of the drum (tegmen tympani) is more open in childhood, so that there is greater danger of involvement of the brain in diseases of the tympanum in children than in grown persons.

The internal and external bony plates of the mastoid process are thicker in the child, because of the imperfectly developed mastoid cells.

Blood Vessels of middle Part of Ear.—The Eustachian tube receives its main blood supply from the ascending pharyngeal artery, a branch from the external carotid, which supplies its mucous membrane, its muscular apparatus (see below), and sends branches into the tympanum. In addition to this, the tube receives a small branch from the middle meningeal artery before it enters the cranial cavity.

The tympanum receives its blood supply from several sources. Through the anterior wall enter: 1. Small branches from the Eustachian tube, as just mentioned; 2. Small branches from internal carotid through its tympanic wall, as stated above; 3. A branch from the temporal artery enters through the Glaserian fissure.

Through the posterior wall, a small artery from stylomastoid enters the drum cavity.

Through the superior wall or roof, branches from the middle meningeal artery enter.

NERVES.—According to *Gruber*, the Eustachian tube receives its nerve supply from the otic ganglion.

The tympanic cavity is richly supplied with nerves. The chorda tympani, so far as is known, has no physiological connection with the tympanum.

The tympanic nerve (Jacobson's) is a branch of the glosso-pharyngeal, and enters through the floor of the drum and spreads out mainly upon the promontory. The carotid plexus of the sympathetic sends several nerve twigs through the posterior wall of the carotid canal to the drum. The trifacial nerve (trigeminus) sends a small twig to the tympanum. All these nerves unite to form the tympanic plexus on the inner wall of the tympanic cavity, usually called promontory. Some of the nerves of this plexus are large enough to cause visible grooves in the surface of the macerated bone. The plexus is sometimes called Jacobson's, as its chief nerve bears that name. It supplies the entire mucous membrane of drum cavity and mastoid cells, and, according to some, it sends microscopic twigs to the tympanic end of the Eustachian tube.

Muscles of middle Part of Ear.—These are properly divided into two sets, internal and external.

The *internal* include the tensor tympani and stapedius.

The *external* comprise all the pharyngo-tubal muscles, heretofore considered as belonging properly to the soft palate and the pharynx. Recently it has been discovered that these muscles bear a more important relation to the Eustachian tube than to the palate and pharynx. Hence they belong more properly to the tube. *Gruber* has so considered them.

The *tensor tympani* lies just above the tympanic end of the Eustachian tube, and its canal is separated from the tube only by a very thin plate of bone. In fact, the muscle is sometimes considered as lying in the upper part of the tube and separated from it by a kind of partition, and the whole is therefore called, by some, canalis musculo-tubaris.

The muscle arises from the cartilaginous portion of the tube and from the bony canal in which it lies, and runs outward and backward, parallel with the tube, till it reaches the cavity of the drum. There the tendon bends nearly at right angles with the body of the muscle around the extremity of the bony septum, commonly called processus cochleariformis (rostrum cochleare—*Gruber*), and runs outward across the cavity of the tympanum, to be inserted on the inner edge and anterior surface of the manubrium just below the short process, as already indicated (see Tenotomy Tensor Tympani above).

L. Mayer, of Munich, has recently investigated the minute anatomy of the Eustachian tube, and seems to have demonstrated that a part, at least, of the tensor veli palati muscle extends outward and into the body of the tensor tympani, and is, therefore, disposed to regard them both as a single double-bellied muscle. *Gruber* lays considerable stress upon this statement, and thinks there may be spasm of the tensor tympani of a sympathetic nature, in cases where the tensor veli palati is involved in diseases of the throat.

The action of the tensor tympani is to draw the handle of the malleus inward, and make the membrane tense, and, at the same time, to rotate it slightly upon its axis. (See Tenotomy Tensor Tympani above for details.)

NERVES.—The tensor tympani gets nerve supply from two sources—the otic ganglion and the internal pterygoid nerve, a branch of the trigeminus.

Luschka thinks that the otic filament controls the in voluntary and the trigeminal branch the voluntary action of the muscle.

The *stapedius muscle* is an extremely small bundle of muscular fibres that arise from the walls of the small canal in the body of the eminentia pyramidalis in the posterior wall of the tympanum. Its tendon emerges from the apex of this eminence, and runs forward to be inserted on the neck of the stapes, from which fact the muscle derives its name.

The effect of its action is not well understood. Some think that it, in some way, counteracts the tensor tympani, which is very doubtful.

This muscle gets its nerve supply from the facial.

PHARYNGO-TUBAL MUSCLES.—There are two of these, according to *Troeltsch*—the *abductor* or *dilator tubæ* (also called spheno-salpingo-staphylinus, circumflexus palati or tensor palati mollis), and *levator paliti mollis* (also called petro-salpingo-staphylinus).

In this group *Gruber* includes a third muscle, the *palato-pharyngeus*, which has a somewhat distant connection with the Eustachian tube.

1. The Abductor Tubæ arises from the wings (about their base) and pterygoid processes (internal plate) of the sphenoid bone and from the anterior upper margin of the blunt-hook cartilage and the adjacent membranous part of the tube (*Troeltsch*), and runs close along the tube downward to the hamular process, around which its tendon winds and passes horizontally inward, to be inserted, according to *Gruber*, in the fascia of the pharynx and the fibrous border on the posterior margin of the hard palate; according to others, the tendon spreads out, and is inserted in the median line of the soft palate, or joins the tendon of the muscle of the opposite side. According to *Gruber* and others this muscle does not arise directly from the membranous portion of the tube, but is connected with it only by connective tissue. *Troeltsch* describes this connection by means of connective tissue, but holds that some of its fibres have a direct origin from the membranous tube.

The hamular process, for all practical purposes, may be regarded as the point of insertion or fixation at the lower pharyngeal extremity of the muscle. Its *action*, therefore, is to draw its movable points of origin toward the hamular process, that is, outward and downward. These movable points are the blunt-hook cartilage and the membranous part of the tube; but these constitute the whole external or lateral wall of the tube: consequently, when the muscle contracts, the whole outer or lateral wall is drawn away (abducted) from the middle or inner wall of the tube—that is, the membrano-cartilaginous part of the tube is opened. It is now pretty well settled that this part of the tube opens or dilates every time deglutition takes place. The abductor tubæ, being the chief, if not the only means by which this is accomplished, must contract every time we swallow. Every one, who has extensively inflated ears, knows that the tube opens or enlarges, so as to enable the air to enter easier, every time the patient swallows.

It is now considered that the contraction of the abductor muscle has no perceptible effect upon the position of the soft palate. It neither makes it tense, nor elevates it, nor constricts the throat, as formerly supposed.

2. The Levator Palati Muscle arises from the under surface of the petrous portion of the temporal bone, near the carotid canal, and, according to *Gruber*, from the lower edge of the posterior end of the tubal cartilage (*Troeltsch* denies that this muscle has any connection with the tube, except to lie in contact with its under surface), and runs downward and inward close beneath the floor of the tube and internal to the abductor muscle, and is inserted partly in the fibrous border on the posterior margin of the hard palate, partly in the anterior surface of the soft palate, and partly in the fibrous raphe (median line) of the soft palate (*Gruber*).

As already stated, this muscle lies against the floor of the tube, and, when it contracts, it presses the lower wall near its mouth upward, and partly closes its pharyngeal opening. *Troeltsch* says this partial closing of the mouth of the tube is proven by actual inspection by the use of the rhinoscopic mirror. Besides this effect upon the tube (which *Gruber* is disposed to deny), its contraction lifts or elevates the soft palate, from which fact the muscle gets its name.

This muscle must have a close connection with the act of respiration, as, according to some writers, the soft palate rises, the pharyngeal mouth of the tube is lessened, and the density of the air in the drum is increased with every inspiration; but the nature of the process is not well understood.

It will not be forgotten that, as already stated, some of the fibres of the levator palati mollis muscle pass upward and backward, and enter directly into the body of the tensor tympani muscle, and that, in consequence of this connection, the two muscles are considered as a single *biventrical* muscle (*L. Mayer*).

3. THE PALATO-PHARYNGEUS MUSCLE.—Only a part of this muscle is connected with the Eustachian tube, but that portion bears an important relation to it, and hence *Gruber* has placed the whole along with the other tubal muscles.

It arises from the median line of the soft palate, from the fibrous border on the posterior edge of the hard palate, and from the lower back portion of the middle (internal) part of the cartilage of the tube, and a few fibres from the membranous tube (*Rebsamen*, *Henle*). In its origin, it blends with other muscles of the pharynx, particularly with the levator palati mollis. From the points of origin, the muscle passes outward and downward behind the tonsil, forming, together with the mucous membrane, the posterior pillar of the soft palate. A part is inserted in the posterior median line of the pharynx, some of the fibres passing over to the opposite muscle. A part of the muscle passes down, and is inserted in the outer surface of the thyroid cartilage, while some of its fibres terminate in the fascia of the pharynx.

When the muscle contracts, that part coming from the tubal cartilage draws it backward and inward, while that portion coming from the membranous part of the tube draws its point of origin backward and outward (*Gruber*, *Rebsamen*); consequently the mouth of the tube is more or less opened by this muscle.

There is a great deal to be learned yet in regard to the physiology of the pharyngo-tubal muscles and their action upon the Eustachian tube. Out of the numerous theories, I have given what I consider to be the most nearly settled facts in regard to the matter. Future investigation will no doubt throw much light upon the whole subject.

INFLATION OF THE DRUM (tympanum) [catheterization, air-douche].—This operation consists in blowing a stream of air through the Eustachian tube into the cavity of the drum. To do this, three instruments are necessary: 1. *Ausculting tube*; 2. *Eustachian catheter*; 3. *Balloon*.

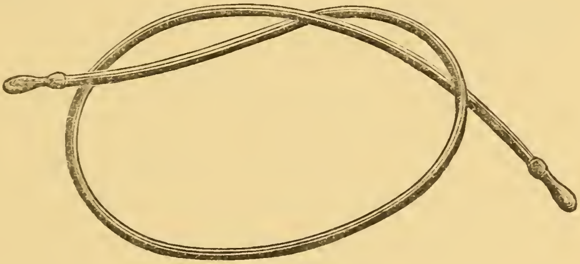

Fig. 15.

1. *Ausculting Tube* (otoscope, diagnostic tube) is a small India-rubber tube (see Fig. 15), from two to two and a half feet long. The less weight it has the better. Its ends are usually tipped with bone or ivory points, which are not essential; they only secure a greater cleanliness.

Fig. 15.—Ausculting tube (otoscope, diagnostic tube).

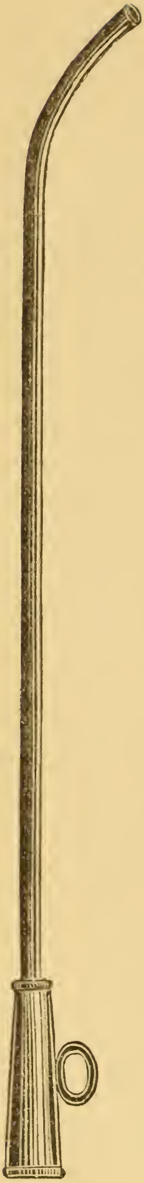

Fig. 16.

2. The *Eustachian catheter* (aural catheter) is a gutta-percha or silver tube [see Fig. 16] (the silver is always to be preferred), of various sizes, generally three in number, so as to suit the age of the patient in general, and the size of the nose calibre in each particular case. It is not uncommon to have to use the smallest size upon grown persons. The medium size most nearly suits all cases. The catheter, of course, must be long enough to reach from the pharyngeal opening of the tube to the point of the nose. It should project from one to two inches beyond the nose (outward). The inner end of the catheter is bent slightly upon itself about one-half inch from its extremity, so as to make it enter the mouth of the tube. The outer end is funnel-shaped for the reception of the point of the blowing apparatus, and to its side a small ring is attached, to indicate the direction of the inner bent end.

3. The *Balloon* is so named from its shape. It is also called *air-bag*. The one I use is simply a No. 2 *Goodyear's patent syringe* (see Fig. 17), with its point sawed off and sharpened, so as to fit in the outer funnel-shaped end of the catheter. A small round hole is punched in the base of the balloon, in order that it may fill from without, and not have to be removed from the catheter every puff.

Fig. 16.—Eustachian catheter (medium size).

In Germany they have balloons made expressly for inflating purposes, but the accompanying syringe is more durable, and answers every purpose admirably, and can be had in every India-rubber store, and is cheaper.

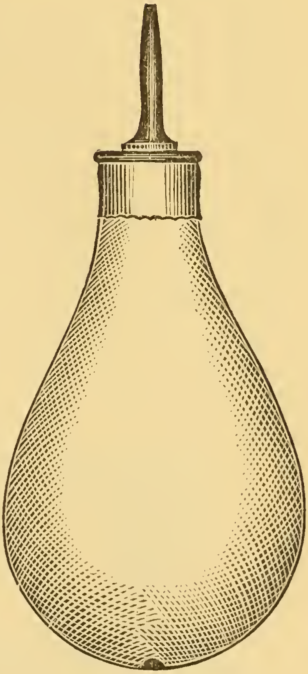

Fig. 17.

Modus Operandi.—The patient is to be seated in a chair, with the back against something solid, as the wall, against which he can rest his head, if desirable, and which will prevent his pulling away backward. Some of the German aurists recommend the standing position for inflating the ear. This *looks very awkward*, particularly with ladies. I much prefer the sitting posture. I place another chair (which should be higher than the patient's) to the front, and close to the left side of the patient's chair. Having supplied myself with the three necessary instruments, I seat myself upon this second higher chair, and place my feet to the left of the patient (his left). Having briefly explained the nature of the operation, with the assurance that it will not be *painful,* but *exceedingly unpleasant*, I proceed to place one end of the ausculting tube (the physician should always use the same end) into my left ear (the position makes that most convenient), so that it will hang without holding. At the same time the

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Fig. 17.—Balloon (air-bag), half size.

patient places the other end into his ear (whichever one it may be), and lets it hang. It is never advisable to hold the tube in the ear when it can be avoided, as the pressure may interfere with the passage of the sound through it.

I now take the Eustachian catheter between the index and the second fingers of the right hand, with the body of the instrument resting across the back of the rest of the fingers. Taking care to hold the catheter *loosely*—*never grasp* it—I insert it, as it were, *back-handed* into the nose, raising at the same time, with the thumb of the left hand, the end of the nose, so as to let the catheter enter easily (see Fig. 18). At first the point of the catheter must be directed upward, until it passes over a little eminence usually present in the floor of the nose, near its orifice, then suddenly raise the body of the instrument to a horizontal direction, and move it slowly and gently along the floor of the nose till the end passes over the soft palate into the cavity of the throat. The concave side of the catheter should always

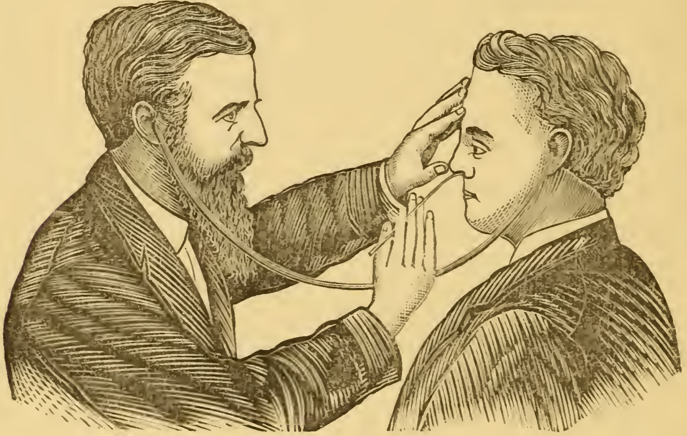

Fig. 18.

Fig. 18.—Method of introducing catheter.

look downward, so the bent point will slip close along the floor and not catch among the turbinated bones.

As a rule, there is no difficulty in thus introducing the catheter. Care must be taken, however, never to do violence to the mucous membrane of the nose.

If obstacles are met with, the catheter must be loosely held in the fingers, so that its point may be allowed to hunt its way through. Sometimes it is necessary to let it turn clear over before it will pass in. *Force* should *never* be used. If it will not go in without that, it had better not go at all. If the instrument accidentally passes in between the lower and middle turbinated bones, it must be withdrawn and entered afresh, as it is impossible to turn its point into the mouth of the tube in that position.

As already stated in the anatomy of the tube, its pharyngeal mouth lies a little above the floor of the nose and a little behind the soft palate. The instrument being once in the cavity of the pharynx, the next step is to turn its point into the mouth of the tube. This is done by turning the point of the catheter horizontally outward, and, not unfrequently, even above the horizontal. Its exact direction is always indicated by the ring on the outer end. Knowing about where the mouth of the tube is, its position can be guessed at, and, with a little experience, a person can strike it with the end of the catheter nearly every time. If, however, it proves to be a miss, then the mouth of the tube must be felt for by moving the instrument a little back and forth. By the feeling it must be judged whether the catheter is right or not. If the end is in the tube, it can not be turned upward beyond the horizontal, or very little so ; its point comes solidly against the upper wall, and can not be turned further. So, also, can the posterior wall be felt; the anterior and lower not so distinctly, as the instrument glides too easily over them on account of their oblique position. But the best test is to blow the wind through the catheter; if it enters the drum, that is positive proof that the instrument is in the tube.

If the catheter is passed too deep beyond the mouth of the tube, it comes into what is called the fossa of Rosenmüller (a little depression behind and above the mouth of the tube), which gives very much the same feeling as the tube proper. In such cases, the deep position of the catheter will show the mistake; besides, the air can not be made to enter the drum.

Most of the German authorities recommend the catheter to be carried in till its point comes against the posterior wall of the pharynx; then it is withdrawn about half an inch and turned into the tube, as just described. I do not follow these directions for good reasons: 1. It is not necessary to do all this; 2. The contact of the instrument against the back part of the throat causes violent spasms of the muscles in many patients, and even severe gagging efforts, and sometimes actual emesis, if the instrument is not removed.

Troeltsch advises beginners to introduce the catheter first on the half head, then on the whole head of the cadaver, then on themselves, and then, lastly, *venture* to introduce it on patients. This is all well enough; but the objection to it is that it makes a simple, easy operation appear very difficult, and tends to deter physicians from undertaking it. The only essential prerequisite is the necessary knowledge of the anatomy of the parts, and a good idea of the locality of the mouth of the tube, and a little common sense to prevent doing violence to the nose or throat.

The catheter being properly in the tube, it is held in position between the thumb and index finger of the left hand, the rest of the fingers lying on the forehead and nose of the patient, as a support.

Now, everything is ready for the third and last step in inflating the ear, which consists in blowing the air into the drum. I take the balloon in the right hand, place its nozzle into the outer end of the catheter, into which it should fit closely, so as to prevent the air from escaping around its point, and then press it with force enough to drive the stream of air through into the tympanic cavity. In pressing the balloon, the end of the thumb must always come upon and close the little hole in its base, so the contained air will all be driven through the catheter. When the bag is empty, to refill it, it is only necessary to raise the thumb and let the air enter through this opening, which prevents or obviates the necessity of removing the balloon every puff, to let it refill through the nozzle.

During the act of blowing, the physician, having previously adjusted the ausculting tube, will hear distinctly the noise of the air, as it enters the drum, which is, as already stated, positive proof of the proper introduction of the catheter in the first place, and of the permeability of the Eustachian tube in the second place. If he fails to hear the sound of the air, one of two things must be true: either the catheter is not in the tube, or the tube is closed. In such cases, the catheter must be readjusted and the effort continued till the air enters the drum, or the diagnosis of obstructed or closed tube can be made.

The position of the catheter in the tube and the relation of all the parts to each other are well illustrated in the accompanying cut (see Fig. 19). The position of the fossa of Rosenmüller is also well shown. It is something of a depression just behind and above the mouth of the tube, caused mainly by the projection of the tube into the pharyngeal cavity. It will be observed from the cut that the catheter, in position, lies close down upon the floor of the nose.

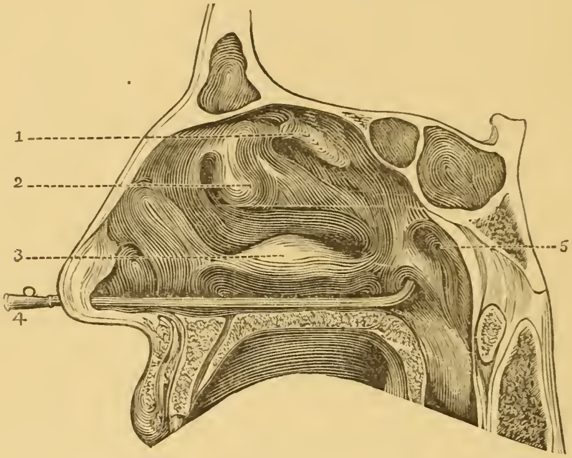

Fig. 19.

The accompanying cut (see Fig. 20) gives a good idea of the whole operation.

General Remarks.—Considerable tact, and some little experience, is necessary to enable a person to inflate an ear readily and comfortably. The general profession look upon it as a very difficult operation, and very few physicians undertake it. The difficulty lies mainly in the disinclination and general indifference, to some extent at least, of medical men on the subject. Any one can do the operation, if he would only sufficiently inform himself and *try*. No man can practice

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Fig. 19.—Catheter in situ. 1, 2, 3. Turbinated bones; 5. Fossa of Rosenmuller.

otology successfully without being able to inflate the drum.

During the operation the ausculting tube must not be allowed to touch the clothing, as the noises produced thereby will interfere with the auscultation. Neither should the tube be pressed, for that checks the passage of sound through it entirely.

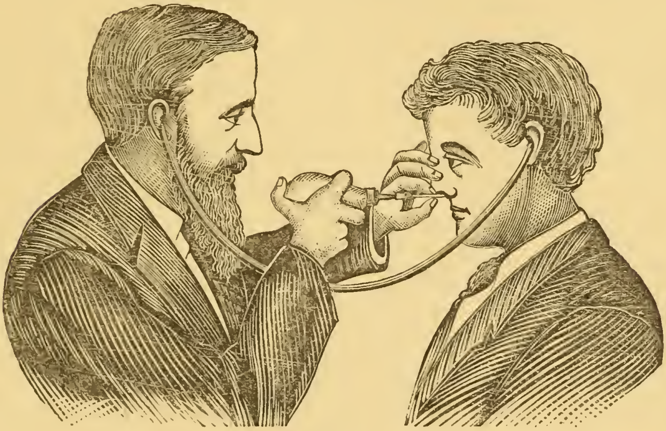

Fig. 20.

As already stated, the medium-sized catheter will most nearly suit all cases. I use it almost exclusively in grown persons, and nearly always in young folks over ten years of age. It is too large for small children, and, in fact, it is hardly possible to practice catheterism on young children. Occasionally the smallest catheter has to be used on adults, when the nasal passage is unusually narrow by nature or the result of an injury. Experience teaches that, as a rule, the left side of the nose is narrower than the right.

The catheter, after use, should always be well cleansed with hot water, if possible, so as to avoid communi-

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Fig. 20.—Process of inflation.

cating contagious diseases, as syphilis, from patient to patient. Cases have been reported where syphilis has been communicated in this way. It becomes every one, therefore, to guard against it, and particularly so when syphilitic patients are being treated.

Now and then there is serious trouble in passing the catheter from physical obstruction, as a tumor, particularly polypi, in the nose or throat. In such cases, of course, the treatment should be directed first to the removal of the obstruction and then the catheterization.

As the air enters the tympanum, the operator must *auscult* the ear and make out his diagnosis: whether there is obstruction in the tube; whether the tympanum is filled with mucous or pus, or whether it is entirely free—in a natural condition. The inflation enables him to do this. It becomes, therefore, an important means of diagnosis. It is impossible to give a correct idea of all the sounds to be heard in the various conditions of the drum. That must be left to the good judgment of the examining physician.

The noise heard in a healthy ear is a *gentle* blowing, which seems to be near the operator's ear; not so far away as the patient's ear. This blowing noise is modified in every conceivable way, according to the nature of the diseased condition.

The principle in ausculting the ear is exactly the same as in auscultation of the chest.

In blowing the air into the drum, it is not easy to do injury to the parts, but *undue violence* must always be avoided.

The catheter, I repeat again, should be held not *tightly*, but *loosely* in the fingers, as that is less painful. Pinching the margin of the nose between the fingers and the catheter is to be avoided on account of the pain it produces.

Sometimes it is necessary to move the point of the catheter in various directions slightly, so as to free it from the folds of the mucous membrane and collections of slime about the mouth of the tube before the air will enter. At other times, when there is considerable obstruction in the tube, it will enter only when the patient swallows ; a proof that the tube opens, at least slightly, in the act of deglutition.

The length of time the inflating process should be continued at each sitting must be left to the judgment of the physician. Generally speaking, a few puffs, after the air enters once freely, will be sufficient. Following the inflation the patient's ear may feel a little full for a short time, but this will soon pass off. During and after the operation the patient sometimes complains of more or less dizziness, which will last only a moment.

ACCIDENTS IN INFLATION.—About the only accident that happens in inflating the ear, is where there is ulceration or abrasion of the mucous membrane, and the air is forced through into the cellular tissue, giving rise to what is called *emphysema.* This generally makes its appearance under the skin, beneath the ear, and may extend down over the neck and throat. The air can be felt under the skin, and the patient will, perhaps, hear the crackling when the jaw is moved. This will alarm him considerably, but, in itself, it is a very small matter, as it will pass off usually in less than twenty-four hours. When the emphysema is considerable, it will cause an ugly swelling about the neck. If the air gets into the soft palate, and puffs it up very much, it may cause symptoms of suffocation. These can be relieved at any time by pressing the soft palate away from the epiglottis with the finger. If the air can not be pressed out where it came in, then several punctures should be made into the palate and the air forced out through them. This will give permanent relief. Under such circumstances the fears of the patient must be allayed by assurances, from the physician, of no danger, at the same time explaining the nature of the trouble to him. Emphysema does not very often happen, and, in an ordinary degree, is perfectly harmless. I have caused it several times already, but have never had any trouble with it. When emphysema once takes place, it is not advisable to repeat the operation on the same person for some time, as it is sure to occur again.

Light hemorrhage from the nose and from the mucous membrane about the mouth of the tube is not uncommon after catheterization. This occurs mostly in cases where it is necessary to press the point of the catheter somewhat into the tube, as when there is considerable swelling about its mouth. In just such cases emphysema is likely to take place.

When it is necessary that the catheter should go pretty deep into the tube, the authorities recommend that the instrument be pressed against the vomer, as a kind of fulcrum. This is always painful. I prefer to make a fulcrum of my fingers, with which I hold the catheter; as I blow I press its outer end toward the median line with the balloon. This brings the inner end deeper into the tube and saves the pressure upon the septum of the nose and the consequent pain.

Compression Pump.—*Gruber* and *Troeltsch* have both given cuts of an apparatus for blowing purposes, intended to take the place of the simple balloon above described, which they call compression pump. It is a complicated affair, in which they "raise the wind" by working a crank up and down (*Gruber*), or by working a piston out and in (*Troeltsch*). It is both weighty and expensive, and, as I think, worthless for practical purposes. Some years ago I ordered *Troeltsch's* compression pump in order to try it, but very soon abandoned it. In my judgment there is nothing equal to the India-rubber balloon for blowing purposes, though it sometimes proves tiresome to the hand when frequently used; the one I use not so much so as those larger ones recommended by the German aurists.

Instead of using the balloon, as above recommended, some writers recommend that the physician should take the end of the catheter into his mouth and inflate the drum with his own breath. This is very unpleasant to both doctor and patient, and is entirely unnecessary, as there is no advantage in it over the balloon. I, therefore, never practice it.

Besides the *catheter* method (catheterization, catheterism) of inflating the tympana, other methods are in vogue, which are known as Valsalvian method and Politzer's method.

VALSALVIAN METHOD.—Everybody knows that this consists in holding the mouth and nose tight and blowing so as to force the air into the drums. Sufficient force can be exerted in this way, in adults, to drive the air into all tympana, except where there is very serious obstruction or actual closure or obliteration of the tubes. Notwithstanding the ease with which the drums can usually be inflated by the patient himself, it is found in practice that the Valsalvian method is almost worthless as a *curative* means, but valuable as a means of investigation or examination and diagnosis in grown people. In infants and small children it is not practicable at all.

The uses of the method in examination will appear hereafter in the diseases of the drum.

Politzer's Method of inflating the drum is based upon the physiological fact that, every time a person swallows, the soft palate rises up and shuts off the lower part of the pharynx from the upper and the Eustachian tube opens, at least slightly, by the action of the pharyngo-tubal muscles, as already described. *Politzer* has taken advantage of this open condition of the tube and closure of the lower part of the throat by the soft palate, and inflates the drums at the most opportune time, to wit, in the act of deglutition.

This is done by using a large-sized rubber bag with a nozzle of convenient length. This nozzle is introduced an inch or so into one or the other side of the nose; then the sides are pressed down upon the tube and the septum of the nose close enough to make it air-tight (see Fig. 21). Now, the patient is directed to swallow, and, as he does so, the physician presses or squeezes the gum-bag with one hand and forces the air into the upper pharyngeal space; and, as the tubes open somewhat at the same time, the air is driven simultaneously into both drums, as is evidenced by the membranes bulging outward in the act. Auscultation does not prove much, as the fluid in the throat and the contraction of the muscles obscure the slight noise of the

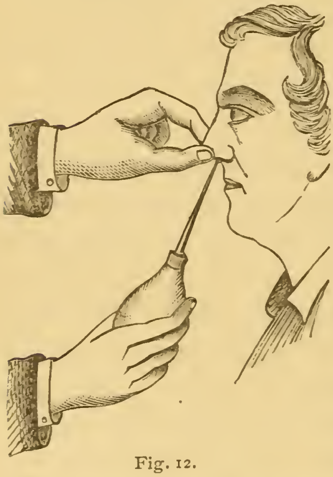
Fig. 12.

Fig. 21.—Politzer's method.

air in the ear (*Troeltsch*). *Politzer* usually gives the patient a sip of water, so as to enable him to swallow at the right time. Instead of the bag, the physician may blow into the end of a tube in the patient's nose, but the use of the bag is much more desirable.

Politzer claims, and seems to have proven, that his method is much more effectual than the Valsalvian experiment, and is, therefore, to be preferred to it. Its superiority is probably attributable to the fact that the inflation by Politzer's method takes place *during* the act of swallowing. Were it possible to perform the Valsalvian experiment or method in the same way, it would certainly be as effectual; at least much more so than it is found to be in practice.

The objection to *Politzer's* method is that both ears, from necessity, are inflated at the same time. Then, again, the air is only forced into the drums; no counter-current, as in catheterization, is established by which collections of any kind in the tympanic cavities would probably be removed. For this reason, if no other, *Politzer's* method can never take the place of inflation by means of the catheter. Then the use of the catheter is much more effectual in a curative sense on account of the greater force and the recurrent stream, and is much more satisfactory in a diagnostic sense on account of the easy and perfect auscultation it affords. For these several reasons I rely almost exclusively upon the use of the catheter and rarely use *Politzer's* method. This is specially indicated in children where catheterization is not practicable, and in grown persons where there is excessive timidity or physical obstructions in the nose so the catheter can not be introduced.

Troeltsch lays considerable stress upon the fact that, in *Politzer's* method, the treatment can be intrusted to the patients. This is, to say the least, somewhat risky, as they are so liable to overdo the matter, and do themselves harm. "If a little is good, much is better," is the ordinary reasoning on the subject among the common people, and, consequently, patients would be disposed to disregard the directions and cautions of the physician, and injure themselves by too frequently and, possibly, too violently inflating their ears.

Effects of Inflation.—The most important of these is, perhaps, the *physical* effect of inflation; the method always being by the use of the catheter (catheterization), when not otherwise expressed. The stream of air physically dilates (to a limited extent of course) the Eustachian tube in passing through it; when the air has reached and filled the cavity of the drum, it physically distends the cavity—that is, it presses the membrana tympani outward, as is proven by inspection of the membrane during the act of catheterization. Inflation has no particularly beneficial effect upon the mastoid cells.

In the next place, inflation has a cleansing effect upon the tube and drum. As soon as the air enters and fills up the drum and mastoid cells, a counter-currrent is established, the tendency of which is to carry back into the throat whatever fluid collections there may be in the drum and tube. Thus the inflation *washes*, so to speak, the cavity of the tympanum and Eustachian tube with air, just as the external meatus is washed (cleansed) with water. Every one knows very well that a stream of water, injected into the external meatus, carries out, by its counter-current, whatever that canal may contain. The principle, in inflation, is the same exactly; the passage to the drum being so much smaller, making due allowances for the difference between the physical properties of air and water, the cleansing effect of the air may not be so thorough. It is difficult to cleanse the drum cavity perfectly by inflation, as the tympanic orifice opens above the floor of the cavity; which fact would seem to indicate that the tube is not intended so much for means of escape or exit as for purposes of ventilation.

THE INDICATIONS FOR INFLATION readily appear from its physical and cleansing effects. In general terms, inflation should be practiced in obstruction of the tube from whatever cause, and in all fluid collections in the cavity of the drum, whether mucus, pus, or blood. In such cases, the stream of air opens up the tube, cleanses the drum, and restores an equilibrium between the air without and within the drum cavity. As a result, a long train of symptoms, such as noises, more or less deafness, fullness in the ears, vertigo, etc., dependent upon these conditions in the tube and drum, are relieved temporarily or permanently, according to circumstances. But the particular indications for inflation in the severe diseases of the tube and drum will be given more in detail below.

Inflation makes auscultation of the ears *possible*, and is, therefore, as already stated, an important means of diagnosis as well as treatment.

DISEASES OF TYMPANUM AND EUSTACHIAN TUBE.

These are few in number, and all are inflammatory in character. The pathological process, therefore, in all, is inflammation, which naturally enough causes different subjective and objective symptoms in differently constituted subjects. Accidental circumstances too modify, very materially, the characteristics of inflammation. Among these modifying influences, I may mention climate, season of the year, healthy or unhealthy season, good or bad health of the individual, constitutional taints, and so on.

The manifestation of widely differing symptoms by the inflammatory process has given rise to a difference of opinion among authors as to the best and most correct classification of the diseases of the middle part of the ear. Considering, as *Gruber* does, that the primary and essential process in all is inflammatory, and, in order to simplify the whole matter as much as possible, I shall make the following, as I think, appropriate subdivision of the diseases of the drum and tube:

1. *Acute inflammation of tympanum and tube* (otitis media acuta).
2. *Catarrhal inflammation of tympanum and tube* (otitis media catarrhalis).

The facts seem to warrant such a subdivision of this somewhat difficult subject, which, as I think, secures the greatest possible simplicity, and, at the same time, is comprehensive enough to include all that properly belongs to the inflammatory diseases of the middle part of the ear. I place the Eustachian tube along with the drum, because the same disease involves both at the same time. There may be an occasional exception to this statement, as will appear in the consideration of the individual diseases, but that is the rule. I am well aware that writers, particularly *Troeltsch*, speak frequently of *tubal catarrh;* but my experience teaches me that it is so nearly impossible to distinguish the diseases of the tube from the drum, or *vice versa*, that I do not consider it advisable to make the effort, which would probably result in confusion.

In general terms, the causes of the diseases of the tube and drum are identical with the exciting causes of affections in the throat, the mucous membrane of which is continued into and lines them completely. Hence, *common colds* play an important part in the general causation of tympanic affections, and satisfactorily account for everything among the laity. How frequently does the otologist hear patients say, "I took a *severe cold*, and ever since then my ear has been so and so." The fact is, that most of the diseases under consideration are extensions of throat affections into the tube and drum. The extension is *by continuity*, and the general principles of disease show how easily and frequently that may occur.

ACUTE INFLAMMATION OF THE TYMPANUM AND TUBE (otitis media purulenta of *Gruber*).—This develops usually suddenly, and, if let alone, will run its course rapidly, and subside either totally or partially. In the latter event, the acute trouble subsides into what is called *chronic purulent inflammation* of the drum. (See Tympanic Otorrhœa below.) As already stated, the disease is often secondary in its character; that is, it frequently, if not in the majority of cases, accompanies or follows acute inflammation of the throat and nose, which condition is popularly called *bad cold:* hence the people think and declare that the bad cold was the starting-point of the ear trouble. Every one knows very well that bad colds (acute naso-pharyngitis), in their development, manifest three short but well-marked stages: 1. The dry or congestive stage, in which the throat and nose are unnaturally dry. This, however, lasts comparatively a short time, perhaps not over a few hours. 2. The moist or watery stage follows the dry, as is indicated by the copious flow of water from the nose and the moist condition of the throat. This watery secretion changes rapidly into pus and thick mucus, which marks the beginning of—3. The purulent stage, which is characterized by a free secretion of pus and mucus from the surface of the inflamed mucous membrane. This is constantly blown from the nose and cleared from the throat till the bad cold is well and the head is free.

The acute inflammation of the tube and drum being, as a rule, so closely connected with acute naso-pharyngitis, must partake largely of the same nature, if, indeed, it is not even identical with it. The inference, therefore, is that the disease in the drum would run through the same dry, moist, and purulent stages, as in the throat, but possibly in more rapid succession, as the tympanic membrane is thinner and more delicate. The rapidity with which the suppuration sets in is a prominent characteristic of the disease; hence *Gruber* names it otitis media *purulenta.*

Causes.—Besides the *bad cold* cause, just referred to, the next most frequent cause is the acute exanthematous diseases—measles, scarlet fever, small-pox; to which the continued fevers may be added as an occasional cause of acute inflammation of the tympanum. The eruption of the exanthematous diseases takes place, to some extent, on all the mucous membranes, that of the drum being no exception. While other mucous membranes may recover without suppuration, that of the drum is very apt to suppurate on account of the almost closed cavity in which it is contained. As soon as the exanthematous inflammation begins in the mucous membrane of the tube, the swelling closes the calibre of the tube, and prevents the ingress of air and the egress of whatever secretion may take place in the drum cavity. The want of ventilation and the accumulation of secretions, together, aggravate the inflammation of the tympanic mucous membrane, and cause it to suppurate.

Then, again, as already remarked, spontaneous inflammation in the drum is occasionally observed where no evident cause can be made out.

In general terms, whatever influences are apt to excite inflammation in mucous membranes, in general, may produce inflammation in the drum.

SUBJECTIVE SYMPTOMS.—The patient suffers intensely. The pain is not confined to the ear, but extends to the face and whole side of the head. If both ears are involved, the whole head is painful. The teeth may become painful. *Troeltsch* says: "It is sometimes difficult to tell whether the pain is in the upper molar teeth or in the ear."

The pain exacerbates at night; the patient can not sleep, and can not get even a little rest: for want of which and in consequence of the suffering, his strength is rapidly reduced. Great heaviness and fullness about the ear are complained of. There is always a high degree of deafness, which sometimes becomes complete.

Distressing noises of all kinds are constantly present in the ear. Bells, hammers, blacksmiths, steamboats, etc., are heard. The patient sometimes thinks that these noises are real, and looks around to see where they come from. The suffering is often increased by movements of the lower jaw, as in swallowing and chewing.

In the meantime, more or less febrile disturbance of the general system shows itself, and usually increases toward evening, when considerable delirium may supervene. To all this add vertigo, and sometimes nausea, and the picture is complete.

From this array of symptoms, it is not difficult to imagine that the patient's countenance would have a peculiarly sad expression in acute tympanic inflammation. Nor is it strange that physicians, not unfrequently, mistake acute inflammation in the drum for cerebritis or meningitis. The similarity in symptoms is very striking indeed. In children, in whom this form of acute aural trouble is quite common before they are able to talk and tell where they suffer, it is no easy task to diagnose between a brain disease and such an aural affecfection; particularly so when there is nothing about the child's ear to attract the attention of the physician.

Some years ago, two or three prominent physicians of Cincinnati treated a child, as they supposed, for acute meningitis. The symptoms were so severe they all thought it would die. Suddenly a discharge appeared in one ear, which was the first intimation they had of any ear trouble, and immediately the brain symptoms subsided. Just now I am treating a child for tympanic otorrhœa. When the trouble began, some six weeks ago, the attending physician thought the child had acute meningitis, and prognosed accordingly. A discharge appeared in each ear suddenly, and put an end to all brain symptoms.

The only way for physicians to avoid making such mistakes, is to look into the child's ears under such circumstances, and see if there is any trouble in the drums. This is easy enough said, but it is not so easy to make a satisfactory examination of the ears of a small child; but it can be done, and should be done much oftener than it is by general physicians.

These head symptoms, most probably, are caused by pressure upon the fluids of the labyrinth, through the fenestra ovalis and fenestra rotunda. The pressure upon the sympathetic filaments of the tympanic plexus may have some influence in producing the brain symptoms. The intimate vascular connection between the tympanic and cranial cavities may cause an actual congestion, of a sympathetic nature, of the meninges and, possibly, substance of the brain. Some of the German writers entertain this last opinion or idea in regard to the brain symptoms.

Objective Symptoms.—As already stated, the nose and throat, the latter more especially, are *usually*, though not always, acutely inflamed, the patient having more or less difficulty, and some pain often, in swallowing. If the exanthemata are the cause of the ear trouble, the inflammation of the throat will depend upon the same cause. It is rare, however, that a physician is called to examine the ear during the exanthematous inflammation of the throat; that, being *self-limited*, passes off in comparatively a short time. On the contrary, a similar inflammation in the drum, when once started, perpetuates itself on account of the tympanic cavity becoming closed, as stated above, until, finally, suppuration takes place, the accumulated pus breaking through the membrane and discharging externally, giving rise to tympanic otorrhœa (see below).

The membrana tympani, in the early stage of the disease, has an increased redness, which is due to the inflamed mucous membrane inside shining through it. The glistening appearance of the membrane is changed somewhat. The handle and short process of the malleus commonly remain visible, which distinguishes the passive or secondary inflammation of the membrane from acute myringitis, already considered.

At a later stage the membrane is pressed somewhat outward, either as a whole, or one or more points rise above its general surface. As the pressure increases, from within, by continued purulent accumulation, these points, sooner or later, begin to show a yellowish tint, caused, most likely, by the pus within showing through the thinned membrane. Or a secondary process of suppuration is set up in the substance proper of the membrane in consequence of the internal pressure. The yellowish tint increases, till, finally, the membrane ruptures, or ulcerates through, in one of these points, rarely in more than one place. The light spot is reduced early to a mere point, or disappears entirely, on account of the change of curvature of the membrane.

In general terms, the changes in the membrane are the result of passive or secondary inflammation.

Diagnosis.—The history of the case makes this comparatively easy. If a painful affection of the ear accompanies or follows closely upon an attack of acute naso-pharyngitis, or one of the eruptive (exanthematous) diseases, there is very little doubt as to the diagnosis. The only disease for which acute inflammation of the drum may be mistaken, is acute myringitis. The characteristic history of the latter distinguishes it readily from the former. Besides, the appearance of the membrane is different in the two diseases.

Pathology.—The pathological process is inflammation, as is implied in the name. It is not known whether there is a pathological difference between spontaneous (following bad colds) and exanthematous (following the eruptive diseases) inflammation of the drum.

The pathology of these self-limited eruptive diseases is not settled. They may have a specific poison and they may not.

Prognosis.—Acute inflammation of the drum, as such, may be said to be self-limited. It runs its course, as a rule, in a few days; does its work of destruction upon the membrane, and subsides into a chronic form, resulting in and perpetuating a purulent discharge from the ear, which I shall treat of below, as tympanic otorrhœa. This disease of the drum rarely ever terminates without causing a perforation of the drum-head. The prospect, so far as the hearing is concerned, is in proportion, as a rule, to the size of the perforation. The smaller ones will heal; the largest will not. The hearing power will depend again upon the amount of damage done to the ossicula auditus and the mucous membrane of the drum.

There is more or less danger to the life of the patient on account of the close proximity and intimate connection between the tympanic and cranial cavities (see Anatomy above).

The most skillful treatment does not always prevent a perforation of the membrane; in fact, it is sometimes advisable to make an *artificial* perforation, for reasons that will appear soon.

TREATMENT.—In order to get a correct idea of the nature of the best treatment, it is well to recall for a moment the condition of the ear. As soon as the trouble begins, the swelling of the walls of the Eustachian tube closes its calibre, and makes the drum, practically, a closed cavity. The inflammation of the drum cavity goes on, and soon pus begins to form. This, in a short time, fills the cavity, and begins to press the membrane outward. In all probability the pus enters into, and accumulates in, the mastoid cells. The general condition of the drum, therefore, is very similar to a deep-seated abscess. The main indication for treament is also similar. The great object is to give vent to the pus and mucus that collect in the drum. The best way to do this is by inflating the tympanum. The wind, in passing, mechanically opens and frees the tube, and the confined accumulations are thus allowed to discharge, at least in part, into the throat. This is certainly the most rational way to treat acute inflammation of the drum, so soon as the diagnosis is established. In cases of doubt the inflation may become necessary, in order to confirm or disprove the diagnosis. As might be supposed, inflation is not very painful in such cases; besides, it affords almost instant relief, when it succeeds well, from the distressing feeling and severe suffering. Inflation affords not only relief, but it gives the very best security against injury to, or destruction of, the membrana tympani and the little bones of the drum.

The frequency of the operation must depend upon circumstances; once, twice, or even three times per day, if the amount of suffering requires it, till the recovery is complete. Usually, one inflation a day is sufficient. The operation should always be performed with the greatest gentleness in the manipulations; still, in pressing the balloon, force enough must be used to make the wind enter the drum freely, for upon that depends the success of the treatment. If the force of the air should cause the membrane to rupture, that would be no misfortune, but rather favorable, as the secretions could then escape externally into the meatus.

If, from any cause, inflation is impracticable, or, if practicable, it does not give satisfactory relief to the symptoms, then *paracentesis* of the membrane should be made at once, and the pus allowed to discharge externally. The incision should be pretty liberal, so as to afford an easy exit to the secretions. The method of the operation has been given above. The puncture should be made in the most prominent point of the membrane; that is to say, where it would most likely rupture, if let alone. The proper place is usually indicated by a yellowish spot or some other characteristic mark. After the puncture is made, the ear should be immediately inflated by catheterization, if practicable; if not, *Politzer's* method may be substituted. The object of the immediate inflation is to drive everything out of the drum into the meatus. This should be repeated once a day at least, so as to keep the incision in the membrane open as long as possible. If, however, it should close (it often closes, in spite of all efforts, in twenty-four hours), and the ear become painful again, the operation should be repeated, and so on, till the recovery is complete. In favorable cases, the suppuration ceases in from one to two weeks. It not unfrequently happens, however, that the acute inflammation subsides into a chronic form, which perpetuates the discharge indefinitely. This chronic inflammatory condition of the drum, accompanied with a constant suppuration from the drum cavity, is what I will, hereafter, denominate tympanic otorrhœa; its treatment will be given under that head.

I do not believe much in internal medication in order to reach acute tympanic affections. The German authors, particularly, recommend a rigid antiphlogistic treatment, both locally and internally. I rarely ever purge, except there is a special reason for it; then I use only mild cathartics in preference to the drastic. I may say I never blister in *acute* affections of the drum. I have no objections to applying one to five leeches to the ear, but think they can be easily dispensed with. I never make cold applications to the ear, but very often apply warm fomentations; of these, I like the hop-poultice the best, and frequently use it. Next to this, I direct the ear to be filled repeatedly with warm water. Instead of the warm water, the steam from boiling water may be allowed to stream against the ear. But, as an external local application, I use, a great deal, anodyne solutions, for the purpose of alleviating the suffering. Of these, the very best, because most effectual, is a solution of atropine (3 to 5 grs. to ounce of water), several drops of which should be dropped into the ear every two or three hours, according to the amount of pain. This often relieves the suffering very promptly and effectually. For children, the solution should be weaker (1 to 2 grs. to ounce). Morphine solution may be used locally in the same way. If these anodynes, used locally, do not relieve the suffering, then I give liberal doses of opium internally, particularly Dover's powder, which determines to the skin. The opiates should be given, more especially, at night.

In cases where perforations have taken place, or where punctures of the membrane have been made, the mucous membrane of the drum may be medicated from the external meatus by *mild* astringents, particularly a weak solution of comp. nitrate of silver, but only after copious suppuration has set in. In an earlier stage, the astringents are apt to aggravate the inflammation. I never inject medicated solutions into the drum through the catheter, as I do not think it advisable to do so.

The catheterization is to be continued, whether paracentesis has been made or not, till the recovery is complete.

The external meatus must be kept clean by syringing it as often as necessary.

The usually accompanying throat trouble must be treated as particularly indicated. In general terms, warm applications are to be used externally over the throat in the acute stage. The warm vapor from hot water may be advantageously inhaled. After the acute stage has somewhat subsided, very mild astringent solutions may be used in the throat, as gargles. A warm solution of common salt is perhaps the best. According to my experience, it is not well, in such cases, to treat the throat very severely. Over-treatment should always be avoided.

The resulting perforations in the membrane are always to be left to themselves to heal. No treatment specifically aids the healing process in them.

When the tympanic inflammation depends upon one of the exanthematous diseases, and the patient is quite sick, it is well to wait a little till convalescence begins, before catheterization is attempted, as it is difficult to succeed well in the operation on a sick person. Besides, in the eruptive stage, the mucous membrane of the nose is often so swollen as to make the passage of the catheter through the nose very painful. Usually, the development of the disease and the progress of the suppurative inflammation are so rapid that the patient hardly has an opportunity to call the attention of his physician to his ear, much less to consult an otologist, before the membrane is perforated or ruptured. In fact, the otorrhœa is sometimes the first evidence the patient has of trouble in his ear, the pain being attributed to the general headache that always attends the exanthematous disease. Consequently, the physician is rarely consulted in such cases before the otorrhœa has actually set in.

CHRONIC INFLAMMATION OF THE DRUM (purulent).—The acute inflammation, just considered, often subsides, as I have already said, into a chronic form, which, without treatment, is disposed to continue indefinitely. A purulent discharge from the tympanic cavity always accompanies the chronic inflammation, and forms its chief and most annoying symptom. This discharge from the tympanum I will call *tympanic otorrhœa* hereafter, and its treatment will be given under that head (see below).

CATARRHAL INFLAMMATION OF THE DRUM AND TUBE.—Aural catarrh must be made *very prominent* among the diseases of the drum, as it is the most frequent cause of incurable deafness of all the tympanic diseases. Only mucous membranes are subject to catarrhal affections; consequently, aural catarrh must always refer to a catarrhal inflammation, or condition, of the drum and tube, as they are the only parts of the ear that are supplied with mucous membrane. It is, therefore, incorrect, in a pathological sense at least, to speak of catarrh of the external meatus, as no such disease occurs there. Catarrh of the throat, however, plays an important part in aural catarrh, as will appear very soon.

Catarrhal inflammation is very similar to common inflammation, if, indeed, it is not identical with it. Pathologically, it is impossible to explain the difference between the two inflammatory processes. The popular idea is that catarrh is an offensive, disagreeable, intractable, persistent, and almost incurable affection of the mucous membrane, which, if let alone, or allowed to advance beyond a certain point, is very apt to end in consumption and death. The first part of the popular idea is not far wrong, but the latter part comes from the warnings of quack advertisements of *specifics* for catarrh, and is false. Catarrh never produces consumption in a non-consumptive individual.

The distinguishing characteristic between catarrhal and common inflammation is the character of the secretion. In ordinary inflammation the secretion is muco-purulent, the pus largely predominating; in catarrhal inflammation the secretion is puro-mucous, the mucus, which often has a shiny appearance and is usually tougher than ordinary mucous secretion, predominating to a large extent. The amount of secretion in each disease varies in its different stages, and also in the *relative* amount of mucus and pus.

Another difference is found in the comparatively acute and chronic nature of the two diseases.

Common inflammation progresses more rapidly and is more disposed to terminate by resolution; catarrhal inflammation, on the other hand, advances, as a rule, much slower and is much less disposed to get well of itself.

Catarrh is no respecter of persons. Anybody, whether in good or bad health, may have it. As a class, however, the so-called scrofulous individuals are most subject to it.

Aural catarrh partakes of the same nature as catarrh in general, and is therefore characterized, in the earlier stages more particularly, by excessive secretion of mucus. After the catarrh has continued for a long time, the mucous membrane undergoes such changes that the secretion varies in quantity and quality; it may even cease entirely, leaving the membrane dry after many years' duration. This has led authors recently to describe a dry catarrh (sclerosis—*Troeltsch;* otitis media hypertrophica—*Gruber;* proliferous inflammation of drum—*Roosa*) as a more or less distinct disease of the drum. My observation teaches me that there is such a thing as *moist* and *dry* catarrh; but I am satisfied that the moist and dry character is produced by different stages of the one catarrhal process: the moist corresponding to the early or first stage; while the dry condition of the membrane indicates the last stage of the disease, when the membrane has undergone such changes that it has almost ceased to be a mucous membrane. The dryness follows naturally upon these changes. A very similar condition to this is often observed in the well-known xeromatous condition of the conjunctiva after a siege of granulations. For these and other reasons I shall not confuse this somewhat difficult subject by trying to describe two kinds of aural catarrh. I hold that there is only one catarrh, which, however, may, and often does, produce very different changes in the mucous membranes of different persons; the symptoms, both objective and subjective, are likewise different. The same disease rarely affects different persons exactly alike.

Aural catarrh is usually divided into *acute* and *chronic*, each of which has a distinct description. The tendency of this division is not to simplify the matter, as it is intended to do; besides, the facts do not warrant it altogether. A properly acute catarrh is the rarest exception; its very nature is to be chronic—very chronic. Persons may have it for months, and even years, without knowing it, and it rarely gets well in grown persons without treatment; children not unfrequently recover from it—at least they are much more likely to recover than adults.

In its commencement and development aural catarrh is very insidious. It may cause considerable deafness before the patient discovers, usually accidentally, that he is even hard of hearing. When he is told that he has catarrh of the drum, he is often slow to believe it; the popular impression being that catarrh is not only unpleasant and difficult to cure, but constantly more or less painful. A painful aural catarrh is of very rare occurrence.

Predisposing Causes.—I have already said that anybody may have aural catarrh, regardless of the condition of his general health. While it is true that a very ugly form of the disease not unfrequently develops in an individual, who, to all appearances, is in perfect health, it is also true that persons in bad health are more likely to have it. Hence poor health may be regarded as a predisposing cause of aural catarrh. The well-known scrofulous diathesis is the most common predisposing cause, particularly in children, with whom scrofula is more common, as a class, than in adults. It would be expected, therefore, that children would be more subject to catarrhal affections in general, and of course to aural catarrh, than grown persons. This proves to be true in practice. Every one knows how common a mucous discharge is from the naso-pharyngeal membrane of children and young people. The same is true of the mucous membrane of the tube and drum. The tuberculous diathesis is another predisposing cause in grown persons more particularly. People who have a *catarrhal diathesis* are always predisposed to aural catarrh.

Exciting Causes.—I am convinced, from observation, and I think I am correct, that aural catarrh is mostly secondary in its development; that it is an extension of a catarrhal inflammation of the throat into the tube and cavity of the drum. This is extension by continuity, and every one knows how easy that may take place in membranous structures. Pharyngeal catarrh, then, is the chief exciting cause of aural catarrh. The throat, at least, is nearly always more or less involved, and it is reasonable to suppose that the pharyngeal trouble is the original or primary affection, for the reason that the throat is so much more exposed to the influences that commonly cause inflammation in mucous membranes, and consequently it is more liable to attacks of catarrhal inflammation than the cavities of the tympana, which are so well protected against external influences, particularly the sudden atmospheric changes, which are so fruitful causes of the nose and throat trouble. In cases where there is no pharyngeal catarrh present, there usually remain evidences of its having existed. The throat may have gotten well, while the aural catarrh, when once established, is, to a great extent, self-perpetuating, on account of the nature of the tympanic cavity, and therefore rarely gets well without treatment. It is not to be inferred from these statements that I do not believe that there is such a thing as primary, spontaneous aural catarrh. I simply wish to say that it is extremely rare. I do not remember ever to have seen a well-marked case. The throat affection is so common that I have come to regard it as a part of the aural disease. Patients usually have a correct idea of the matter, and nearly always date the ear trouble back to a *severe cold* in the head or throat. Bad colds, then, are another exciting cause, at least indirectly, of aural catarrh, and it is surprising to see what a *role* they play in the history of cases, as given by the patients.

According to *Gruber*, the exanthematous diseases and the different continued fevers may produce aural catarrh. I do not remember that I was ever able to trace the disease to such a cause. The same author says that syphilis may cause it. A *specific* inflammation can not properly be called *catarrhal*.

Subjective Symptoms.—As already stated, a person may have aural catarrh for some time without knowing it. After while he discovers, perhaps accidentally, that he does not hear well. His friends may call his attention first to the fact. The slight deafness, at first, gradually increases till it becomes very annoying to him, probably, in the course of a few months or even longer. His friends have to repeat things in order to make him understand. Soon a very faint noise begins in the ear. This may have been noticed, but disregarded, even before the deafness was discovered. At first, the patient hears it only at night, when everything is still, when it often sounds like the singing of an insect in the distance. It increases gradually as the disease advances, and the hearing grows worse, until finally it may become distressing in every sense. Patients compare it to hammers, bells, steamboats, cars running, musical sounds, and, in short, it sometimes seems that all manner of external sound is represented in the diseased ear; not all in one patient, but different sounds in different persons, so that, in a number of patients, the whole category of sounds may be represented. "Blowing off steam" is a favorite comparison. Some time ago a patient told me, "It often thunders in my ear."

Need any one wonder that this great variety of sounds should produce the saddest and most distressing complaint of the patient? The commingling of incessant sounds of all descriptions sometimes makes him frantic, and, in fact, almost crazy. How often does he say, "I would give the world to get rid of these tormenting noises! Just anything to relieve me of them!" Sometimes patients go so far as to threaten self-destruction, if there is no hope for relief from the *bedlam* of noise. With such patients, the deafness is comparatively a small matter.

There is a sensation of fullness and heaviness about the ear; a "*choked*" feeling in the throat; deglutition seems to be somewhat difficult. Constant efforts are often made to get something out of the back part of the nares and upper part of the throat. Occasionally there are cracking noises, like the bursting of bubbles, in the ear, particularly in the act of swallowing. I treated a young lady, some time since, who could produce a regular *mucous rale* in her ears by performing the Valsalvian experiment. The cracking I could distinctly hear by listening with my ear close to hers.

More or less dizziness or swimming in the head is often complained of.

Objective Symptoms.—The external meatus, as a rule, is normal. The membrana tympani is redder than natural in the earlier stages of the catarrh; but the redness has a peculiar character: it is transmitted redness from within, which gives the membrane a dark, slightly red appearance, which is very different from the characteristic redness of acute myringitis (see above). It requires some little experience to be able to tell whether the redness is in the membrane proper or in the mucous membrane of the drum. The exercise of a little judgment, in making the diagnosis, is very essential. In aural catarrh, the short process and handle of the malleus remain distinctly visible, which shows that the substance of the membrane is not much involved, if at all. It will be remembered that these disappear very early in acute myringitis.

The cone of light, I may say, assumes all sorts of shapes. It is mostly reduced in size, frequently to a mere point, and sometimes it is wanting entirely. These variations in the light spot depend, of course, upon changes in the curvature of the membrane. When there is considerable swelling or collection of secretion in the drum cavity, so as to interfere with a free circulation, there may be some secondary congestion of the membrane, as indicated by the injected condition of the vessels of the malleus handle, and perhaps also of the marginal vessels.

The general surface of the membrane is usually unnaturally concave. Some portions may be much more concave externally than the general surface. It is not uncommon to see a sudden and deep depression in front of the manubrium, close along its anterior margin or edge.

In the later stages, the membrane often becomes somewhat thicker—at least apparently so—and whiter than natural. In such condition, it seems to contain very little blood; in this respect, it resembles somewhat white atrophy of the optic nerve. On the other hand, portions of the membrane become thinner occasionally, as by a process of absorption in its substance. This gives the membrane something of a spotted appearance—some portions are too white, while others are too dark. The dark places are sometimes seen to rise up and fall back when the Valsalvian experiment is performed.

Calcareous deposits of various sizes and shapes, pearly white in appearance, often take place during the progress of aural catarrh. The deposits occur in the substance of the membrane with no regularity as to form. The nature of the process is not well understood (see above).

The external meatus is sometimes partly filled with hardened wax; more frequently, however, it is unusually dry, the wax secretion being apparently checked. The epithelium of the skin often seems to be disposed to break up into fine scales like bran.

As already stated, there is, almost without exception, either actual catarrhal inflammation in the throat, or there is good evidence of its having been there. The appearance of the throat varies with the stage of the disease. In the earlier stages, the mucous membrane will be moist and soft, its surface being covered more or less with the characteristic mucous secretion. In the later stages, the mucous membrane becomes, or may become, unnaturally dry: sometimes it seems to be somewhat atrophied; at other times, the mucous follicles are swollen, possibly by retention of their proper secretion, giving rise to what is usually called *follicular pharyngitis*. This dryness of the mucous membrane indicates, as I think, an *advanced* stage of the catarrhal process. I would not, therefore, call it *dry catarrh*, as *Troeltsch* intimates, but rather *dry stage* of catarrh, which, as I think, harmonizes much better with the facts. The same moist and dry stages occur in the mucous membrane of the drum, as will appear hereafter.

The tonsils are often more or less enlarged, but not uniformly so. Even when they are not, there are sometimes evidences of their having been enlarged. Some writers are disposed to think that enlarged or diseased tonsils are not unfrequently the primary cause of both the pharyngeal and aural catarrh. However this may be, it is certain that enlarged tonsils perpetuate both the throat and ear catarrh.

DIAGNOSIS.—Every catarrh carries with it the idea of a copious secretion—discharge—from which fact the disease gets its name, which signifies "a running." The catarrhal inflammation and consequent swelling in the throat, accompanied by the characteristic mucous or puro-mucous discharge, which is usually seen sticking to the surface of the pharyngeal mucous membrane in spots generally here and there, are sufficient evidence of the presence of pharyngeal catarrh, and, when the above-described subjective and objective symptoms manifest themselves in the ear, there is every probability that the pharyngeal catarrh has extended into the drum. To prove or disprove its presence there, it is only necessary to inflate the ear, and, at the same time, to auscult it. The nature of the sound produced by the stream of air passing into the tympanum, will enable the physician to determine the condition of the drum cavity; whether it is free or healthy, or whether it contains the characteristic catarrhal secretion. The principle involved is exactly the same as in auscultation of the chest, and it is just as easy to detect the presence of fluid in the drum, as it is to diagnose its presence in the air-cells of the lungs. In both instances, a great deal must be left to the good judgment of the physician. The kind of sound he hears in catheterization must reveal to him the nature of the secretion, whether it is tough or fluid. If he finds the drum cavity full, or part full, of secretion, the diagnosis of aural catarrh is established. On the contrary, if it is perfectly free and the wind passes into it in a full free stream, without any interruption or cracking noise, then the inference is that there is no catarrh in the drum. Sometimes the mucous membrane of the drum is unnaturally dry, and the cavity seems to be too large, so that the stream of air enters the tympanum in too large a volume. This indicates that the catarrh is far advanced; that the mucous membrane has shrunken (atrophied) and become dry (xeromatous), and, to all intents, has ceased to be a mucous membrane: hence it does not secrete mucus enough to keep its surface moist. This condition might, with some propriety, be called *dry catarrh*, but it should not be described as an independent disease, as it is, in my judgment, as I have already said elsewhere, only the latter stage of common aural catarrh. I prefer, therefore, to call it the *dry stage*, which is certainly more correct. It would be very proper to divide catarrh of the ear, in general, into two stages—*moist* and *dry*—corresponding to the earlier and later stages of the disease. Every one who observes closely ear diseases, will soon learn to distinguish between these two stages, which is an important matter with respect to the prognosis, as will appear below.

The mucous membrane of the Eustachian tube undergoes the same changes as that of the drum: 1. The *moist* stage, when the tube is too narrow, probably on account of the swelling of the membrane; 2. The *dry* stage, when the tube, according to my experience, is too open. I can give no other explanation for its unnatural patency than the shrinking (atrophy) of the mucous membrane. This condition of the tube is, I may say, always present, when there is the same pathological condition found in the drum. The moist stage, likewise, develops in both tube and drum at the same time. Some of the writers, on this subject, have a great deal to say about *tubal catarrh*. It is questionable, with me, where there is such a thing as an independent catarrh of the tube. My experience teaches me that both tube and drum are simultaneously involved. I have seen numerous cases of catarrhal inflammation of the throat with the usual symptoms of aural catarrh present, but upon examination by inflation only the mouth of the tube proved to be obstructed by a plug of mucus sticking in it; the body of the tube and the drum being at the same time in a perfectly healthy condition. Such a condition of the tube could hardly be called tubal catarrh. In such cases it is only necessary to remove the plug from the pharyngeal orifice to restore the hearing power and to relieve all the other symptoms.

When it is impossible to make the air enter the drum, the inference is that there is some obstruction somewhere in the tube. To determine the nature of the obstruction a close examination is necessary. Pharyngoscopy will show whether there is any abnormal condition about the mouth of the tube that prevents the entrance of the catheter. If the obstruction is not there, then bougies are to be passed through the catheter into the tube, so as to dilate it, mechanically. If the bougies can not be made to enter from one-half to three-fourths inch beyond the inner end of the catheter in position, there is a reasonable suspicion of the actual closure of the tube. But more of this under the head of treatment.

The foregoing shows the great value of inflation, as a means of diagnosis. In a diagnostic sense, it bears the same relation to otology as auscultation does to the diseases of the chest, or the ophthalmoscope to diseases of the eye. Its still greater value, as a means of treatment, will appear below.

I have not dwelt at great length upon the great variety of sounds a person will hear by ausculting a catarrhal ear during inflation. I do not think it would be profitable to do so, as every physician must rely upon his own judgment, after all, for an explanation of the sounds he hears. Every beginner should get as correct an idea of the normal sound of inflation (when the ear is healthy) as possible. Then whatever deviates from the normal standard he will recognize as abnormal, and his judgment must supply the explanation as to the cause of the unnatural sound. If the air passes through fluids of any kind, he must be able to recognize the characteristic cracking sound, like bubbles bursting. If an unnatural amount of force has to be exerted before the air enters the drum, perhaps whistling sharply, as if it was being pressed through a pin-hole, the inference is that the tube is much too narrow. On the other hand, if the stream of air enters too easily and freely, the conclusion is that the tube and drum are too large, probably in consequence of atrophy of the mucous membrane, as already stated, and so on.

In diagnosing, as well as prognosing, in aural catarrh, it should not be forgotten that the condition of the mucous membrane of the throat is a pretty fair index to the condition of the same membrane in the tube and drum, allowing for the natural difference in the anatomical structure of the membrane in the two places.

Neither have I given, in great detail, the numerous appearances of the membrane in making out the diagnosis of aural catarrh, for the reason that they are deceptive, and consequently unreliable. The appearance of the membrane, in a diagnostic sense, is of secondary importance, being only corroborative evidence of catarrhal inflammation of the drum.

THE PATHOLOGY of catarrhal process, in general, is not well understood. It is now pretty well established that it is an inflammatory process, but wherein the catarrhal differs from the common or purulent (suppurative) inflammation is not known. The peculiar discharge in catarrh would indicate that the disease spends its force mainly upon the mucous follicles or glands, exciting or stimulating them to excessive secretion of mucus; hence the characteristic mucous discharge that accompanies and distinguishes every catarrh in its earlier stage. These general remarks apply with equal force to aural catarrh as well as pharyngeal catarrh. The hypersecretion of mucous (moist stage) continues for a while, till the disease destroys or so changes the mucous follicles that they cease to secrete any more, in the proper quantity, their peculiar product (mucus). Now, the membrane becomes drier than natural; the so-called dry stage sets in. The required time for the disease to run through the moist stage is very indefinite. It may be a few weeks, a few months, or several years, depending upon its severity and the constitution of the patient. A healthy system resists its progress longer than an unhealthy one.

More or less inflammatory swelling (congestion) of the membrane takes place early in the disease, and continues usually during the moist stage. This congestive swelling is generally sufficient to close or obstruct the Eustachian tube, whereupon the subjective symptoms at once begin. About the time the moist passes into the dry stage, hypertrophy of the membrane takes place. In fact, it seems that the transition is in consequence of the denser (compared to the congestive) swelling of the membrane, a kind of thickening, which I call hypertrophy. The mucous follicles of the throat often swell about this time in the progress of the disease, forming, as already stated, what is called *follicular* pharyngitis. The hypertrophied condition of the membrane persists for an indefinite time; it may last for months, and, again, it may last many years. Sooner or later, however, an opposite process begins. The membrane undergoes a shrinking process, which ends finally in atrophy. The atrophied condition in the tube and drum may be detected by inflation, as already stated, in the diagnosis. Atrophy of the mucous membrane may be regarded as the end of aural catarrh, or of catarrh in general.

But the changes that take place in the drum are the most important, so far as the proper function of the ear is concerned. In the hypertrophied condition of the membrane, plastic material often forms on its surface. When two such surfaces come in contact, adhesions between them are very apt to occur. Thus adhesions often take place between the membrana tympani and the promontory, because, when the tube is closed, the external air presses the membrane inward against the opposite wall. In the same way adhesions form between the incus and the membrane, between the stapes and the membrane, between the tendon of the tensor tympani and the membrane, and so on. These adhesions produce and perpetuate, necessarily, more or less deafness.

The catarrhal process in the muco-periosteal membrane of the drum (it will be remembered that one surface of this membrane is *mucous* and the other is *periosteal*) sometimes extends to the joints of the little bones, and causes anchylosis between them, which is fatal to the hearing power. The foot of the stapes may be anchylosed in the fenestra ovalis, or its movements may be interfered with by calcareous degeneration of its connecting ligament. Calcareous formation may occur also in the membrane of the fenestra rotunda. The membranes of the fenestræ are involved, in all probability, in consequence of interrupted nutrition.

Politzer speaks of a "secondary contraction of the tendon of the tensor tympani muscle," which has an important bearing upon the vibrations of the membrana tympani. It occurs in this way: The membrane is sometimes pressed far inward, and is held there for some time. This relaxes somewhat the tensor muscle, which, after while, undergoes permanent contraction (in accordance with the nature of all muscles), so as to put its tendon on the stretch. This holds the membrane permanently in its abnormal position. Under such circumstances, tenotomy of the tensor tympani is indicated. (See above.)

Such are some of the more important changes that take place in the drum in consequence of aural catarrh, which permanently and seriously interfere with the hearing power of the ear.

It is not always possible to detect the adhesions. The best way to do this is to inspect the membrane during inflation. If adhesions are present, the corresponding parts of the membrane remain fixed, while the surrounding portions bulge outward. White or light-colored spots in the membrane sometimes indicate the points of attachment of the adhesions.

The noises and vertigo, and sometimes vomiting (*Troeltsch*), are produced by pressure, by means of the membrane and the little bones, upon the labyrinth, and through it, indirectly upon the brain.

Aural catarrh does not often lead to perforation of the membrana tympani.

PROGNOSIS.—This must always depend upon the particular condition in which the physician finds each patient. In general terms, the prognosis is favorable in the moist stage, unfavorable in the hypertrophied condition of the dry stage, and *hopeless* in the atrophied condition of the dry stage. Aural catarrh rarely gets well without treatment. With it, most of the cases in the moist stage will either recover or be greatly benefited. Some of the cases in the transition state of hypertrophy of the mucous membrane will be improved, more or less, while there is no hope for any of the cases after atrophy of the membrane has taken place. As soon as the moist stage ceases, the membrane ceases practically to be a mucous membrane, and its full restoration is beyond the reach of treatment.

When adhesions between any parts of the drum can be made out, the prognosis is much less favorable. So also, when there is any evidence, such as a high degree of deafness and a changed voice, of a diseased condition of the fenestral membranes, the prospect is very slim. I regard every case, where the voice has undergone any considerable change of any kind, as hopeless. As the deafness grows worse, the voice may become coarse and noisy, or it may become soft and fine, the patient rarely speaking above a whisper. In both cases, the prospect is equally unfavorable.

Calcareous deposits, which sometimes take place in the membrana tympani during the progress of aural catarrh, are an unfavorable symptom.

The prospect is by no means encouraging when the deafness and noises in the ear are persistent; the hearing never getting better and the noises never changing, much less ceasing.

The condition of the general health has an influence upon the prognosis. An aural catarrh in a healthy, robust person will get well easier than in a sickly, weakly individual, particularly when the sickness or debility is of a permanent nature.

In cases where there is a doubt as to the prognosis, it is always advisable to inflate the ear a time or two, in order to test the matter. If the inflation improves the hearing materially, and checks the noises considerably, the prospect of a permanent improvement is comparatively good. On the contrary, if the catheterization has no perceptible effect upon either the hearing or the noises, the case may be put down as hopeless. Sometimes, however, the sudden recovery of the hearing, even in unfavorable cases, surprises both the patient and the doctor. Some years ago, at Cincinnati, I inflated a young lady's ear, which was quite deaf, two or three times, in order to establish a correct prognosis. One morning the young lady was combing her hair before the glass, and, all at once, "*a pistol went off in her deaf ear.*" Immediately afterward, she observed that she had perfect hearing in the ear, which continued permanently. Other persons have reported similar cases. So far, no reliable explanation has been given of this sudden recovery *by explosion.*

Relapses are common in aural catarrh. Under treatment a case may begin to improve nicely at once, so that the physician is encouraged to think that his patient will be well very soon, when, suddenly, the deafness and noises return as bad as ever, and frequently without any apparent cause. The only explanation I can give is that the disease has a *relapsing* disposition.

The various writers have a good deal to say about *conduction of sound through the bones* of the head, as a means of testing the soundness or unsoundness of the auditory nerve. If a watch is pressed against the temple or upon the mastoid process, corresponding to the deaf ear, and the patient can hear its ticking, the inference is that the nerve is sound; if, on the other hand, the watch can not be heard, the nerve is supposed to be diseased. The same experiment is made by placing the watch between the teeth. A common tuning-fork is used for the same purposes as the watch, with the same inferences when heard or not heard. *Politzer* has, more recently, given the subject special attention, with the hope of reaching definite conclusions, but his results are very unsatisfactory. Were it possible to determine, in this way, whether the auditory nerve is sound, or diseased or dead (not capable of receiving impressions of sounds), the fact would be an important item in the prognosis of aural catarrh, as there is often a question of soundness or unsoundness of the nerve proper. I have tested the matter, in a practical way, pretty thoroughly, and have never yet been able to deduct any satisfactory conclusion from it. I therefore consider the whole matter both unsatisfactory and unreliable.

Gruber, in his recent valuable work, dismisses the whole subject with the single statement of its unreliability.

TREATMENT.—The drum and tube should be kept as clean as possible. The mucus should not be allowed to collect and remain in them, as it is a source of constant irritation to the mucous membrane. The more that is irritated the more mucus it secretes, which, in turn, irritates more. Thus the catarrhal process, when once started, is, to some extent, self-perpetuating. It is very important, therefore, to remove the mucous collections as thoroughly as possible. This is done best by inflating the ear. The stream of air mechanically dilates or opens up the calibre of the tube, and not only *allows*, but, to a certain extent, *forces* all fluid collections from the cavity of the drum through the tube into the throat. At the same time the tubal walls are cleansed. As I have said elsewhere, the inflating process *washes* the tube and tympanum with air, just as syringing washes the external meatus with water. Of course, the inflation, in this respect, is not so effectual as the syringing, but the principle is the same.

Besides the cleansing and mechanical effect of inflation, the air has a beneficial action in a physiological and medicinal sense: it *ventilates* the mucous membrane of the tube and drum in the first place, which is essential to its healthy action; in the second place, the air produces something of an astringent effect upon an inflamed mucous membrane. Physiologically speaking, all mucous membranes are intended to be in contact with the air, while serous membranes are intended to be excluded from direct atmospheric influences. If the air is excluded from the former, it will become inflamed sooner or later; if the latter is exposed to it, inflammation very soon sets in. This statement shows that essential conditions to the healthy action of membranes must be complied with. Air is essential to the physiological action of all mucous membranes. Hence the great importance of a constant supply of fresh air to the tympanum, and particularly so when its lining membrane is diseased.

In aural catarrh, I may safely say, there is always more or less interference with the ventilation of the drum; sometimes the air is entirely excluded. A very slight deficiency in the normal amount of air is sufficient to aggravate, at least, the catarrhal inflammation of the drum.

Inflation presses the membrana tympani outward by the force of the air, and prevents, as far as possible, the formation of adhesions between it and the promontory; or it may even rupture or break up very recent ones, never old ones. In pressing the membrana tympani outward, it relieves the pressure upon the labyrinth. Consequently, inflation is the best known remedy for all kinds of noises in the ear, which, as above stated, are supposed to be produced mainly by atmospheric pressure upon the drum-head from without. Unfortunately, however, it will not relieve all cases of tinnitus aurium.

The combination of the several important good effects of inflation sufficiently accounts for its almost magical effect in some cases.

The ear should be inflated once a day till the hearing and noises are much improved, then once or twice a week till the cure is complete, or till all is accomplished that can be accomplished. The usual time ranges all the way from a few days to three months, or even longer than that, when the patient is extremely anxious to get the full benefit of the treatment. A few cases I remember having treated from twelve to eighteen months, partly to test the effect of long-continued inflation, and partly to comply with the demands, which they (young ladies) made in the hope that their failing hearing might possibly be restored. My failure with them, together with later experience, has taught me that nothing is to be expected of a longer treatment than from six to twelve weeks.

If the treatment by inflation does not improve the hearing power nor relieve the troublesome noises in the ear, it is the best means of preventing the trouble from getting worse. I often advise patients to have their ears repeatedly inflated when I do not expect any improvement, in order, if possible, to preserve what hearing they have left. The authorities recommend for this purpose periodical, if not continuous, treatment once or twice per year, to be continued each time several weeks. This may be good advice, but very few patients will comply with it.

The length of time the inflation should be continued at each sitting must depend upon circumstances, and must be left to the judgment of the physician. I make it a rule to continue it till the drum is cleansed, as will be indicated by the cessation of the mucous rale, or, when there is no mucus in the drum, till the air enters easily and freely. Usually, I find that from six to twelve puffs with the balloon are sufficient, after the catheter is in position.

It will be observed that I have made the cleansing of the drum an important part of the therapeutic action of inflation. This is true only in the moist stage of aural catarrh, when the catarrhal secretion is always present; but in the dry stage, when there is no fluid present, there is nothing to blow out of the drum: consequently, the cleansing effect of inflation in the dry stage is unimportant. So the benefit from inflation in the later stage of aural catarrh must be attributed to its physical effect, and the astringent or medicinal action of the air upon the mucous membrane, together with the good effects of the general ventilation of the drum cavity referred to above. *Gruber* claims that the benefit is attributable, in part at least, to the pressure of the air upon the hypertrophied or swollen mucous membrane (dry stage), promoting thereby absorption. This would certainly be true, if the pressure was continuous, but such slight pressure for so short a time is in this respect evidently ineffectual.

I make it a rule, in examining patients with aural catarrh, to inflate the ear a few times in order to establish a correct prognosis. I do not commit myself to a definite opinion till I have tested the matter in this way. After inflation, the prospect is proportional exactly to the amount of improvement in the hearing and in the noises. After several inflations, if there is no considerable improvement, I consider the prospect very unpromising in both the moist and dry stage, but much more so in the latter. As soon as I have settled the matter of prognosing in my own mind, I tell the patient, and, if he desires a further trial, I continue the treatment for several weeks. If I can not promise him anything in the way of improvement, I can assure him that the treatment is the best means of preserving what hearing he has left. That is about all the encouragement the physician can give in unfavorable cases. The inference is that when repeated inflations fail to make any impression upon an aural catarrh, the disease has produced stiffening or anchylosis of the ossicula auditus between each other, or anchylosis between the foot of the stapes and the surrounding bone, or that adhesions have taken place between different parts of the drum; all of which are beyond the reach of treatment, as the science of otology now stands. Whenever none of these incurable changes have taken place, which interfere either with the vibration of the membrana tympani or with the conduction of sounds through the chain of little bones, inflation has a uniformly favorable action. Indeed, it sometimes acts like a charm in instantly restoring an ear, that has been almost dead to sounds for many years, to health and functional activity. Perfect relief from the indescribable fullness in the ear and heaviness about the head, aside from the restoration of the hearing and freedom from the tormenting noises, often makes a patient look and feel like a new man.

Occasionally a case is met with where there is some physical obstruction to the introduction of the catheter, as when the nose has been mashed or its passage is unnaturally narrow, or when there is some abnormal condition of the parts about the mouth of the tube; also, in small children catheterization is impracticable on account of the impossibility of getting them to hold still. In all such cases, *Politzer's* method of inflating the drum should be substituted for catheterization. From all of which, it will be inferred that *Politzer's* method is applicable, and should be used when inflation in the ordinary way is impracticable.

Inflation by the Valsalvian experiment, as a means of treatment, is worthless. Patients sometimes injure themselves by performing the experiment almost incessantly on themselves.

FORCIBLE DILATATION OF EUSTACHIAN TUBE.—In rare instances, the tube is so firmly obstructed by the swelling of its mucous membrane, that the force of inflation in the ordinary way is not sufficient to overcome it. Either the air can not be made to enter the drum at all, or, if it enters, it *whistles* through as if being forced through a small pin-hole, or it enters only when the patient swallows, in a fine whistling stream. The non-entrance of the air, or the abnormal sounds it produces when it does enter, indicate that there is actual closure (stricture) or considerable obstruction in the tube from swelling of the mucous membrane. To overcome the stricture, or forcibly dilate the obstruction, bougies of various kinds are passed through the tube. The materials mostly recommended for the bougies, are *cat-gut*, *whalebone*, *laminaria digitata*, and *hard rubber*. I prefer those made of the last two substances, perhaps because I have used them most.

The bougies must be as blunt-pointed as possible, and must never be thicker than the normal calibre of the narrowest part of the tube. Three marks are made on them: The first is the exact length of the catheter;

the second is three-quarters of an inch longer—the length of the cartilaginous part of the tube, allowing that the catheter enters a quarter of an inch into its mouth; the third is half an inch longer still, corresponding to the length of the bony part of the tube.

The introduction of the bougies is effected in this way: The catheter being in position, with its point somewhat pressed into the mouth of the tube, the bougie is passed through it till the first mark comes up to its outer end, which indicates to the surgeon that the point of the bougie is just ready to leave the inner end of the catheter and enter the tube. Now, it is passed gently on till the second mark comes up to the catheter, which shows that the end of the bougie has reached the narrowest part of the tube, that is, where the bony part begins. Now, the bougie is passed gently on till the third mark reaches the outer end of the catheter, which shows that the inner end of the instrument has reached the tympanic orifice of the tube. When the end of the bougie projects into the drum cavity, it is sometimes visible through the upper anterior part of the membrana tympani (*Troeltsch*).

This operation is more easily described than executed. It is sometimes very difficult to make the bougie pass through the tube. Decided force must never be used; it is better to rather coax the instrument in. If it does not go in at first, it should be somewhat withdrawn and started in with a rotary motion. The process is to be thus continued till the operation is a success, or till the surgeon is convinced that there is insurmountable obstruction or actual closure of the tube, as is sometimes the case, following syphilitic sloughing of its walls. In that case the pharyngoscope (see below) must assist in making out the diagnosis.

After the bougie has been successfully passed, the wind should be blown in so as to discover the condition of the drum, and also for its beneficial effect. The operation may be repeated once every day, or every second or third day, according to indication, the inflation following each time, but *very gently*, for fear the bougie has penetrated the mucous membrane, which would give rise to emphysema, as has occurred a time or two in my hands. The length of time this kind of treatment should be continued, will depend upon the nature of each case, and must be left to the judgment of the physician. Altogether, the results of forcible dilatation are not very satisfactory.

Patients often complain of quite sharp pain during the operation, but it soon subsides after it is over. The end of the bougie is not unfrequently covered with blood, however gently it may have been introduced.

If it is desirable to dilate the tube to its fullest extent, the bougie of laminaria digitata may be left in for a quarter to half an hour, so as to allow it to absorb moisture and swell; but it must never be allowed to get too tight, for fear it can not be removed, and on account of the severe pain it may cause. The tube should never be dilated beyond its normal size.

From the foregoing it will be observed that I rely almost exclusively upon inflation for the treatment of aural catarrh. Formerly, following the recommendations of the German writers and teachers, particularly *Gruber*, I injected medicated solutions of various kinds into the drum cavity almost daily. There is no difficulty whatever in making fluids enter the drum through the catheter. All that is necessary is to place a few drops of the fluid to be injected in the end of the catheter while in situ, and then blow the wind through with the balloon. With the ausculting tube the water can be heard to enter the drum, and even strike against the membrane.

But I have gradually discontinued the practice of injecting fluids into the drum, and now rarely ever do it. My experience taught me that it was at least *doubtful* whether such a treatment was beneficial or not; besides, I produced, in a number of cases, a severe and quite painful attack of acute inflammation of the drum, which, in neither instance, proved injurious to the ear, but it caused the patients a good deal of suffering and gave me a good deal of annoyance. Consequently, I gave the practice up entirely. I now look upon it as *dangerous* without being *very beneficial.* Some time since *Roosa*, of New York, collected the reports of some fifteen to twenty cases, where severe, and even destructive, inflammation of the drums had followed upon the use of the nasal douche. The explanation was, and it is no doubt correct, that the water (medicated with common salt) forced its way into the drums and excited all the trouble there. Is not the water, injected into the drums, as dangerous as the water from the douche?

Nothwithstanding all this, many of the best authorities, in otology, still recommend the injection of medicated solutions into the drum, and the great importance of a full knowledge of the treatment of aural catarrh leads me to give a short synopsis of their recommendation on the subject.

Troeltsch mentions, as of particular value for this purpose (injection), sulphate of zinc (1 to 10 grs.), chloride of ammonium (10 to 40 grs.), liquor potass

(4 to 40 drops), iodide of potassium (10 to 60 grs.), and iodine in a solution of iodide of potassium (1 to 6 grs. of fomer to a scruple of the latter). The amount of water to be used with each quantity of medicine is an ounce. Any one of these may be injected every day, or once in two or three days, according to special indications. This author claims to have good effects from their use.

Politzer recommends, in cases of moist catarrh, a solution of sulphate of zinc (4 to 8 grs. to ounce of water). This he injects every second or third day for several weeks.

In cases of dry catarrh ("thickening of the mucous membrane and of the covering of the ossicles, with rigidity and diminished mobility"), the same author advises the use, in the same way, of some one of the following solutions: Ammoniæ muriat (20 grs.), potass iodid (10 grs.), or sodii chloridi (5 grs.) to one ounce of water. These are to be used for a few weeks and then intermit for several months, and then renew again. This *Politzer* thinks is the most effectual treatment.

Gruber recommends, in general terms, the injection of astringent solutions, but mentions, particularly, alum, borax, and tannin solutions (20 to 40 grs. to ounce of water). A few drops of these solutions he injects through the catheter once daily, or once in two or three days, as may be indicated.

Roosa thinks injections may have a decided effect upon the lining membrane of the tympanum.

The above-named indicated solutions may be applied to the tube, and perhaps even to the drum, in a *nebulized* or *atomized* form, which, however, does not increase their efficiency in the least, as I think.

German writers, particularly, have experimented extensively with various gases or vapors in the treatment of aural catarrh. *Troeltsch* speaks particularly of the use of the vapor of muriate of ammonia in a *nascent* state, and thinks he has had good effects from it, more particularly in the earlier stages of the disease (moist catarrh). The vapor is generated by a somewhat complicated apparatus, and then blown through the catheter into the drum. It causes very little pain, only an unpleasant biting or stinging sensation in the throat and ear. It is to be applied once a day for several minutes at a time.

The same author recommends highly the use of steam in the latter stages (dry catarrh). The vapor from warm or hot water is blown by means of two India-rubber tubes—the one leading into the flask containing the hot water, and the other connecting the same with the outer end of the catheter through into the drum. The application of the steam is continued for several minutes at each sitting. The steam, of course, must never be hot enough to burn.

Roosa speaks favorably of the effects of steam, and claims the credit of having restored its use in this country.

Some years ago, I tested the *steam* treatment thoroughly, as I thought, and, not being able to see any good results from it, I abandoned it entirely.

In addition to the above, *Troeltsch* has experimented with the vapors of iodine, the different kinds of ethers, chloroform, acetic acid, oil of turpentine, carbonic acid, etc., but found them all about worthless.

Altogether, the results of the treatment of aural catarrh by gases have not been effectual enough to encourage their continued use. When nothing else will do any good, they may be tried as a kind of last resort.

From the foregoing, the following conclusion may be drawn: The local medication of anral catarrh is, more especially, indicated in the earlier (moist) stage; while vapors, if they ever do any good, are most useful in the latter (dry) stage. It must not be forgotten, however, that, in the application of both solutions and gases, inflation is being constantly practiced, and much of the benefit supposed to be derived from their use may be attributable to the good effects of the inflation. Experience teaches me that this will accomplish about all that can be accomplished in the way of local treatment.

Paracentesis of Membrana Tympani in Aural Catarrh has recently become quite popular among aurists, with a good prospect of being carried to great, not to say injurious, extremes.

Without stopping to give the long and somewhat tedious history of the subject, I draw the following conclusions from the immense literature of the operation:

1. The operation is safe, and not very painful.

2. It is particularly indicated when there are collections of mucus or other fluids in the drum, which can not be removed by catheterization; consequently the operation is mostly indicated in the moist stage of aural catarrh, when the mucous secretion is most profuse.

3. I can see no object in puncturing the membrane in the dry (hypertrophied or atrophied) stage, when there is nothing to evacuate from the drum cavity, except, possibly, when the Eustachian tube is hermetically closed; but, in that case, the impossibility of keeping the incision open would destroy its otherwise beneficial effect.

4. Paracentesis of the membrane is a necessary part

of the operation for tenotomy of tensor tympani muscle, which occasionally is indicated in consequence of the results of aural catarrh (see tenotomy of that muscle above), and also in division of adhesions between the membrane and promontory, as recently proposed and practiced by Dr. Prout, of Brooklyn, and by Dr. Weber, of Berlin; but it remains to be seen whether these adhesions do not soon reform after their division, which will determine the advisability of the operation. Its nature involves considerable difficulty and uncertainty: First, in determining the exact location of the adhesion; and, secondly, in dividing it in its concealed position. Its practicability must be determined by future experience. The most appropriate instrument is a small knife, bent on the flat near its point.

For the purpose of simple paracentesis, a long narrow straight knife (as a cataract needle) is sufficient. (See Myringotomy above.)

The choice of location for the puncture, as I have elsewhere stated, is the posterior inferior portion of the membrane, corresponding, as nearly as possible, to the most dependent portion of the tympanic cavity, for obvious reasons.

The incision must be *liberal*, so as to give *easy* escape to the mucous collections within. To facilitate its escape, inflation should follow immediately, which will drive all the secretion from the drum into the external meatus, whence it can be syringed away.

After he has made the incision, Mr. Hinton, of London, forces water through the drum and Eustachian tube, for the purpose of cleansing them, by means of a syringe that fits, *water-tight*, in the external meatus. His theory is, that, in many cases, the deafness and tinnitus are caused by tough mucus in the drum, which can not be removed by catheterization; hence he endeavors to wash it away, as just stated. The same object might be accomplished in a simpler way, namely, by filling the meatus with water, and pressing the tragus down upon it with sufficient force to make it pass through the drum and tube. I will have occasion to refer to this method of forcing fluids into the drum hereafter, under the head of Tympanic Otorrhœa.

Other writers recommend medication of the tympanum through the incised membrane. I do not think this is advisable, for the reason that the mucous membrane of the drum, in a catarrhal state, does not tolerate irritating applications well; imperfectly in the moist stage, and not at all in the dry stage. Suppurating mucous membranes always tolerate treatment very well, which, for some cause, is not the case with catarrhal mucous membranes, as in aural catarrh. For these reasons, I would rely mainly upon inflation after paracentesis of the membrane.

If the incision in the membrane closes, as is usually the case, before its object is accomplished, it may be renewed as often as necessary.

It remains to be seen whether simple paracentesis of the membrane will be a permanent operation in the treatment of aural catarrh or not.

TREATMENT OF THE THROAT is always an important part in the treatment of aural catarrh. I have already said that a catarrhal affection of the pharynx almost uniformly precedes or accompanies aural catarrh, and is often the primary or original disease. The treatment of the throat therefore becomes an important matter. The necessary examination is comparatively easy, as a large portion of the pharyngeal cavity is visible to the unassisted eye; but, in order to make a satisfactory investigation of the upper part of the pharynx and posterior nares, artificial means of illumination are necessary, so as to render the parts visible. The process by which this is accomplished is called

RHINOSCOPY (pharyngoscopy), which is simple enough in itself, but quite difficult to execute satisfactorily. Not wishing to go into a minute description of the process, which would be foreign to my present purpose, it consists in holding a small mirror (rhinoscope, laryngoscope) in the throat in such a manner that it reflects the natural or artificial light that reaches it through the mouth upward, so as to illuminate the upper part of the throat and back part of the nose. Images of these parts are reflected back to the observer, who views them by looking into the mirror. In this way the physician is enabled to detect any very considerable abnormal conditions, as unusual swelling of the mucous membrane, the presence of polypi or other tumors, in these otherwise hidden but important parts of the throat. The same examination reveals likewise the condition of the mouths of the Eustachian tubes—whether the mucous membrane in and around them is healthy or not. This examination of the tubes becomes very important when there is physical hindrance to catheterization. Rhinoscopy should reveal its character—whether it is swelling of the mucous membrane, abnormal development of the tube, or actual closure of its calibre, as, only occasionally, occurs as the result of syphilitic ulceration or sloughing of the mucous membrane, in which event the opposite walls actually grow together. Under such circumstances, of course, nothing whatever is to be expected from treatment. But the examination being over, the general catarrhal condition of the throat must be treated. The same general remark is applicable to catarrh of the throat as was made in connection with the treatment of aural catarrh; namely, the moist stage bears treatment tolerably well, while the dry stage tolerates any kind of irritation very poorly. In general terms, mild caustics and astringents are indicated in the moist, while absorbents and alterants should be used in the dry stage.

My experience convinces me that strong caustic applications do not act well in catarrhal affections of the throat. If they are used at all, they should not be applied oftener than twice per week, or even less frequently. Of the caustics, I find nitrate of silver the best. I apply it always in solution (5 to 20 grs. to ounce of water) with a camel's hair brush, endeavoring always to bring it particularly in contact with the most affected parts of the mucous membrane, as indicated by the more or less circumscribed red spots in its surface. I prefer the brush to the ordinary probangs, because it irritates less; all unnecessary irritation should be avoided. I do not recommend the application of the silver solution to the upper part of the throat and posterior nares, for the reason that, in my hands, it has proven to be too irritating, frequently producing severe pain, and causing water often to stream from the nose for hours afterward. Milder applications certainly act better. The solid stick should only be used when there is ulceration of the mucous membrane, particularly when it is syphilitic in character.

An important part of the treatment of pharyngeal catarrh is to keep the mucous membrane scrupulously clean. For this purpose the throat should be repeatedly washed, if nothing but water is used, so as to remove all collections of tough mucus from the surface of the membrane. These mucous collections in the throat cause no inconsiderable amount of irritation, and, of course, aggravate the already inflamed membrane. The explanation of the beneficial effect of *gargles* in pharyngeal catarrh is to be found, not so much in the medicines which they contain as in their *cleansing* effect upon the mucous membrane. It matters not so much, therefore, what they contain, so the fluid is made to wash the entire diseased surface. It is, however, a long established custom that a gargle must contain some astringent medicine; consequently, it would be difficult to get a patient to gargle his throat with simple water. The remedy being so common, he would have no faith in its virtue. *Troeltsch* refers to the use of pure water for gargling purposes, and thinks that its good effect is attributable to the "gymnastic exercise" of the muscles of the throat and tube in the gargling process.

The following are the substances usually used in gargles: Alum, borax, common salt, sulphate of zinc, sulphate of copper. Of these, alum and common salt are perhaps the best. The strength of the solution varies from three to thirty grains to ounce of water. I always make it rather weak, so as to be sure not to excite too much irritation, as I am inclined to the opinion that the virtue lies in the water as much, if not more, than in the medicine.

The method of using a gargle is very important. If a patient wants to get the fullest benefit from it, he should take a sip of the fluid into his mouth, and let it run deep down into his throat; then, by lying down on his back and letting the head lower than his body, the fluid will run up (so to speak) into the upper part of the pharynx; then, if by turning on his face, he can let it run out through the nose, so much the better. In this way a gargle may be made to *wash* the entire mucous membrane. The ordinary method of gargling the throat by producing the well-known gargling noise is next to useless.

The difficulty experienced in getting patients to use gargles correctly has induced me to rely mainly, in the treatment of pharyngeal catarrh, upon the use of the *catarrhal syringe*. (See Fig. 22.) I first wash the throat and nose thoroughly by injecting, with this syringe, pure water up behind the soft palate, into the upper pharyngeal space and posterior nares, and out at the nose. It is often astonishing to see what amount of mucus and immense plugs of dried secretions that are frequently washed out in this way. After the parts are well cleansed, I inject, in the same way, a small amount (about a teaspoonful) of whatever medicated solution may be desired. I generally use a solution of salt (teaspoonful to pint of water), which, in fact, may be used instead of pure water, for cleansing purposes. This treatment, like gargles, is to be repeated from two to five times a day, according to the requirements of the case.

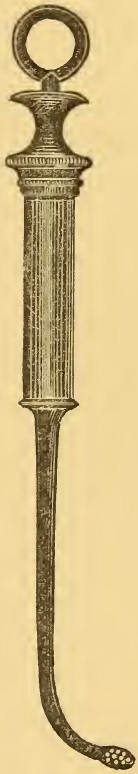

Fig. 22.

I have found this method of treatment very effectual, because the remedies can be brought, with ease, into direct contact with the entire diseased surface; at least I attribute its success to that fact.

The treatment can be safely intrusted to a friend of the patient, if desirable.

There is another very effectual method of washing

Fig. 22.—Catarrhal syringe (half size).

the nose and throat, which consists in using the well-known *nasal douche.* (See Fig. 23.) The nozzle is placed, water-tight, in one nostril; the bottle is then elevated a *little* above the level of the nose, so that the water it contains will enter the nostril, and, when it has filled up the upper pharyngeal space, which, during the process, is shut off from the lower part of the throat by the soft palate rising up against the posterior wall, it runs out through the opposite nostril. The head is inclined a little forward over a basin, into which the water falls. This is a thorough means of cleansing the nose and upper part of the throat, and of medicating the entire mucous membrane after it is cleaned. For cleansing purposes, warm water (pure) should be used; for the purpose of medication, the various gargles described above may be employed. I prefer and nearly always use a warm solution of salt.

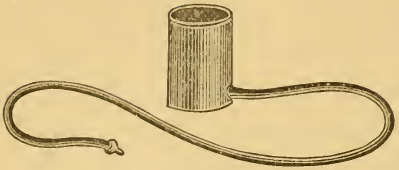
Fig. 23.

Treatment with the douche, like gargles, is to be repeated two to five times per day, according to the amount of secretion from the mucous membrane. I very often direct the salt water alone, which, in that case, both cleanses and medicates at the same time. This does away with the necessity of a kind of double operation, and has the desired effect.

There is one serious objection to the use of the nasal douche. If the water should accidentally enter the drums in considerable quantity, as it may do at any time, it is liable to excite very severe and even destruc-

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Fig. 23.—Nasal douche.

tive inflammation in those cavities. This is always painful, as well as dangerous, to the integrity of the ear. *Roosa* has recently reported several cases of total destruction of the power of hearing from this cause.

I have seen numerous cases where severe pain followed the use of the douche, but I have never seen any serious results from it. When patients complain of considerable pain after its use, it should be discontinued at once.

In order to avoid this accident as much as possible, I am in the habit of directing patients to raise the apparatus only a *little* above the level of the floor of the nose, so the stream of water will not enter the nostril with too much force, and consequently will be less likely to force its way through the tubes. I also caution them against letting it run too long. I direct it to be stopped as soon as it starts out freely at the opposite nostril. This, however, does not do away with the danger; it only lessens it. I have said, in another place, that these serious accidents from the use of the douche should be a strong argument against the practice, now quite common, of injecting fluids of any kind into the drum. Is not the danger the same when the water is injected in as when it runs in?

I have never seen any such accidents follow the use of the catarrhal syringe. I therefore prefer it to the nasal douche in the treatment of pharyngeal catarrh.

In the dry stage, as I have said above, absorbents and alterants are more especially indicated. Among these may be mentioned chlorate of potash, iodide of potash, tincture of iodine, etc. These may be tried; but my experience does not encourage me to undertake a case where the catarrhal process has reached the dry or atrophied stage. As a rule, no good will be accomplished.

The general or internal treatment in aural catarrh must be directed according to general indications. If the patient is in perfect health, no internal treatment is to be recommended. If the patient is scrofulous, the usual anti-scrofulous remedies are to be given. If there is the least evidence or even suspicion of syphilis, the patient must be treated *anti-syphilitically;* and so on.

Dieting is never advisable. I always tell persons to live well, but recommend at the same time regular hours and regular habits. No stimulants should be taken under any circumstances.

Blisters do not compensate in good for the annoyance they cause the patient.

Leeches I never use in common aural catarrh.

A CHANGE OF CLIMATE is to be recommended when everything else fails, the throat resisting all treatment and the ear disposed to relapse frequently. In such cases, a change of climate is absolutely necessary, if the patient ever expects to get well. It is not material whether the change is from cold to hot, or hot to cold, so there is a change.

A change merely of business is not unfrequently beneficial, particularly if the change is from a confining to a more active trade, as from in-door to out-door labor.

A change from the city to the country is to be advised in stubborn cases. Such a change is particularly beneficial in young people.

The various water-cures may be tried, if the patient is able to afford such a luxury. In the West, the hot springs of Arkansas are perhaps the best.

POLYPOUS GROWTHS.—If these are discovered in the nose or throat (their development in connection with catarrhal inflammation of these parts is rare), they are to be removed by tortion or ligature. The pedicle is seized with a polypus forceps and twisted off; or a ligature is passed around the pedicle and drawn tight enough to produce strangulation, which will cause the polypous tumor to slough away. Neither of the operations is as easily executed as the description would seem to indicate. They are sometimes fearfully vexatious to both physician and patient. The otologist, however, is rarely called upon to remove them.

HYPERTROPHIED TONSILS are not an unfrequent complication of aural catarrh. In fact, it is the opinion of some that a swollen tonsil is often the original cause of both pharyngeal and aural catarrh. One thing is very certain, that they are very common in catarrhal throats, but it is impossible to say where the original disease started. They being at least a constant source of irritation, it is impossible to make either the throat or the ear get well without removing them.

If the enlargement is the result of a recent acute inflammation in the gland, or if it is only of a few weeks' standing and rather soft, simple treatment may reduce it.

The treatment mostly recommended for recently enlarged tonsils, is nitrate of silver in strong solution, or in substance (the stick). It is applied freely once a day to their surface, and should be confined to them as much as possible. This is the most common remedy, but all the numerous astringents are also used; but I have not been able to verify their efficiency.

The aurist, however, very rarely sees enlarged tonsils in the recent state. He finds them, as a rule, in a very chronic condition, of several months or even years' standing, very hard and frequently nodular on the surface, with here and there a depression. Their size varies very much; sometimes they are very small, and at other times they are large, projecting far into the cavity of the pharynx, and even meeting in its centre. Cases have been reported where the opposite tonsils had grown together.

The enlargement is not due to an increase of the gland substance proper, but to an increase of the connective tissue, most probably the result of inflammatory exudation.

Patients are often unaware that their tonsils are enlarged, and frequently express surprise when they find it out. In fact, they sometimes stoutly deny that they have, or ever have had, any trouble in the throat, when an inspection will reveal not only enlarged tonsils, but also a general catarrhal inflammation of the pharynx.

When the tonsils are very large, they make deglutition difficult, and interfere with respiration, causing the patient to sleep with his mouth open and to snore often so badly that his friends think he is going to suffocate. The snoring is particularly distressing in children, who are very liable to have enlarged tonsils. Occasionally they are the direct cause of more or less deafness, by physically obstructing the mouth of the tubes (see below).

It requires only an inspection of the throat, to discover and diagnose hypertrophied tonsils.

The Treatment, in the chronic state, is surgical. I always advise their amputation, and urge the operation upon the patient, as it is very necessary for the good of his ears, for his comfort, and for his health, that they should be removed. They may be destroyed by strong caustics, as chloride of zinc, Vienna paste, galvano-caustic, and so on ; but the treatment would continue for several weeks, if not months : the patient would have to suffer considerable. Besides, the remedies themselves are dangerous ; they can not be controlled at will : they might penetrate too deep and endanger important blood vessels.

On the contrary, the amputation is over in a moment, the pain being very trifling, and the patient gets well in a few days.

Some years ago, I tried all the remedies recommended for the purpose of causing the hypertrophied tonsils to absorb, but was not able to see in a single instance any good result; so I concluded that such treatment was useless, and I am still of that opinion. I therefore recommend and urge amputation at once, and be done with it. If the patient does not submit, I do not trouble him with other treatment.

The method of amputation is this : The patient sits in a chair before a window. An assistant presses the tongue out of the way. I take hold of the apex of the tonsil with a fine hook, or, still better, with a pair of long slender toothed forceps, and pull it a little toward the centre of the pharynx, and, with a probe-pointed knife (the hernia knife in every pocket-case answers the purpose very well), I cut through the body of the tonsil, from below upward, or from above downward, as is most convenient. I endeavor to cut through it about upon a level with the arches of the soft palate. I have never seen serious hemorrhage follow the operation. Usually there are only a few drops of blood lost. I direct the patient to wash his throat with cold water till the bleeding stops. After that, if it gets quite sore, to use warm water. The raw cut surface heals over in a few days, and the tonsil, the part remaining, shrinks away.

I prefer to use the knife to all the tonsillotomes I have ever seen. These I regard as awkward and unsatisfactory. I do not use them any more.

Amputation of the tonsil is a perfectly safe operation, and the results are good. The pain it produces is very slight, as the hypertrophied tissue is partly dead. Both tonsils may be operated at the same sitting, if the little hemorrhage from the first does not interfere with the second.

Complete extirpation of the tonsils is not practiced any more as formerly. In the first place, it is not necessary, and, in the second place, it is dangerous, somewhat so at least, to cut so deep beneath the tonsil, as large blood vessels lie close there. Too deep cutting would probably account for the reported cases of serious hemorrhage.

In amputation the ordinary styptics are to be used, if a case should occur where the bleeding is too free. I have never met with such cases.

I can not insist too much upon the necessity of removing enlarged tonsils, as an *essential* part of the treatment of aural catarrh.

DEAFNESS CAUSED BY ENLARGED TONSILS.—A brief report of an interesting case will show the nature of this kind of trouble and the necessary treatment.

Michael ——, æt. 12, American-Irish; robust in appearance, but very scrofulous; has been quite deaf from early childhood. Have to scream at him to make him hear. Can not go to school well on account of his deafness. Hears the watch close to his ears. "Snores *terrifically* at night." Makes so much noise he keeps his mother awake often, although she sleeps in an adjoining room. She often goes in to turn him over for fear he would suffocate. Such was the mother's account.

Upon examination, the ears externally appeared natural. Patient complained of noises in his ears. His breathing was obstructed. Upon looking into his throat, his tonsils were found to be greatly enlarged and very hard; the surfaces were marked by considerable depressions. They filled up completely the spaces between the arches or pillars of the soft palate, and projected inward so far they nearly met in the centre, leaving a space of not more than two or three lines between their apices. The general mucous membrane of the throat was quite red and unevenly swollen. The tonsils were evidently the seat of the original disease, the mucous membrane being involved secondarily. They were manifestly the cause of the difficult breathing and snoring, and also the cause of the deafness, by *physically* obstructing the mouths of the tubes. The appearance of the membranæ tympani showed that the mucous membranes of tympana were, in all probability, free.

This, then, being the diagnosis, the indications for treatment were very plain. Remove or reduce the tonsils and the deafness and other symptoms would disappear. The quickest, best, and surest way to do that was to amputate them, as described above. I advised, and, in fact, urged the operation, but the boy would not consent. I told the mother to persuade him into it. They went off, and in a few days returned; the boy sat down, and I amputated one of his tonsils. I directed him to wash his throat with cold water till the bleeding stopped, and, when it began to get sore, to gargle with warm water. Returned in ten days much better. Could hear well in corresponding ear. The patient sat down and I amputated the other tonsil. Gave the same directions as before. They returned in two weeks much delighted. The boy could hear perfectly; had ceased entirely to snore, and the throat was well, the tonsils having shrunk up. The mother could sleep without interruption.

Thus the treatment and its results confirmed the correctness of the diagnosis.

In amputating I endeavored to take the tonsils off about upon a level with the pillars of the soft palate. That is sufficient, besides it is somewhat dangerous to try to extirpate, for reasons given above.

The good result in this case shows the great importance of amputating enlarged tonsils of long standing. The operation is not indicated in very recent cases.

PURULENT INFLAMMATION OF THE DRUMS IN INFANTS.—*Troeltsch* has described, at great length, a purulent condition in the drums of infants (under a year old), which he discovered accidentally in general post-mortem examinations, and which he calls *infantile aural catarrh*. In a large majority of forty-six ears, taken without selection from the dead-house, he found the drums filled with pus or a purulent fluid. In many of the subjects he found a diseased condition of the meninges and cerebrum. Thus far no definite conclusions have been arrived at, as to the nature of the aural or cerebral trouble, whether the one depends upon the other, or whether both do not depend upon some other primary disease in some other and perhaps distant part of the body, as in the lungs or bowels, which, as in most of the cases reported by *Troeltsch*, was the immediate cause of the death of the child. The latter supposition furnishes, at least to my mind, the most probable explanation of the matter. I can not think that primary purulent inflammation of the drum of infants is so very common, as the fact reported by *Troeltsch*, would seem to indicate.

The complete absence of perforation of the membrana tympani in the forty-six ears goes to prove the secondary character of the aural disease (if it can be considered a disease). Every one knows that *active* purulent inflammation in children leads, almost without exception, to perforation of the membrane.

For these and other reasons I am of the opinion that the changes described by *Troeltsch*, are produced either by a secondary inflammation of a very low grade, consequently giving rise to no active symptoms, or they are changes resulting from the moribund state, or they may be *post-mortem* changes. The infants, before death, were inmates of foundling institutions in Germany, being poorly nourished and badly cared for, and were just the kind of subjects in which moribund or post-mortem changes would be expected.

Dr. Wreden, of St. Petersburg, has investigated the ears of eighty infants, all foundlings, and found a very similar condition to that reported by *Troeltsch*, and inclines to the opinion that the changes are due to secondary inflammation, and states that diseases of the lungs and brain are particularly apt to involve the tympana, secondarily, on account of the close anatomical relation of these parts. The whole subject is surrounded with great difficulty on account of the impossibility of communicating with such small children.

The profession will have to look to those physicians, who have charge of foundling and orphan institutions, for light on the subject. It will require long and patient investigation under great difficulties; but it is to be hoped that somebody will go through with the necessary labor and give the profession the benefit of his conclusions.

It is the *duty* of those physicians who treat children a great deal, to make it a rule to look into their ears and see what the condition of the drums is. This is a matter of vital importance, particularly in those cases where disease of the brain is suspected. Tympanic affections in children similate diseases of the brain to perfection, and often deceptively so in grown persons. I can safely say that the general practitioner, now-a-days, never thinks of looking into the ears of his little patient; but the time will come when that will be an important part of the examination. The number of mistakes made in regard to diagnosis of children's disease is really surprising. In my short experience I have seen and known of numerous cases. Only the other day I saw a child six months old with otorrhœa. In the incipient stage the attending physician had diagnosed brain disease and stated that the child must die, when suddenly a discharge occurred from each ear and all the symptoms disappeared instantly!

Malignant Growths, so far as I know, never develop spontaneously in the drum. Cancers in the neighboring parts sometimes encroach upon and involve the tympanic cavity, as, for instance, epithelial cancer of the auricle and external meatus from without, and cancerous growths starting originally in the throat and in the cranial cavity from within. Such complications, of course, are incurable, and, so far as treatment is concerned, nothing is to be attempted.

Cholesteatoma is a peculiar growth, not well understood, that develops in the cavity of the tympanum, mastoid cells, and external meatus, and sometimes in the cranial cavity. It is regarded as non-malignant in itself, but very malignant *in its effects.* As the growth increases, the pressure upon the surrounding bones causes their absorption, and, sooner or later, the brain is involved and death follows. The authorities say it is developed usually from suppurating surfaces (mostly in connection with chronic otorrhœa—*Troeltsch*), and is composed of numerous concentric (onion-like) layers, which are composed of flakes of epithelium mingled with cholesterine (*Troeltsch*). The cholesterine seems to be formed from fatty material by a kind of metamorphosis. Its nature is not understood, though its formation in the external meatus is quite common. Its shining particles are frequently seen in hardened masses of cerumen.

Cholesteatoma presents a bright shiny appearance, from which fact the German writers designate it *pearl-tumor. Gruber* states that it may easily be mistaken for a collection of wax in the meatus.

TREATMENT.—So far as I know, no particular treatment has been recommended. *Troeltsch* states that, as a rule, the disease proves fatal, not on acccount of its malignancy, but on account of the destruction of the surrounding parts. If its location allows its complete removal, that should be done with the least possible violence. It is not yet known whether cholesteatoma is disposed to return after its removal or not.

OTORRHŒA.

This is, taken in its literal sense, a running of any kind from the ear; but custom applies it more particularly to purulent discharges from the ear. For the sake of convenience I shall treat of otorrhœa under two heads, according to the source of the pus: 1. *Simple otorrhœa*, in which the pus comes from the external meatus; 2. *Tympanic otorrhœa*, when the discharge comes from the cavity of the tympanum. The facts warrant such a division.

SIMPLE OTORRHŒA.—Inflammatory disease often converts the delicate skin of the external meatus into a kind of pyogenic membrane (frequently and improperly called mucous membrane), from the surface of which pus is constantly secreted; hence the constant discharge from the ear.

CAUSES.—It will be remembered that acute inflammation in the external meatus, from whatever cause, ends uniformly in more or less profuse suppuration, which sets in just as the acute stage begins to subside into a more chronic form. When the purulent discharge is once established, there is a peculiar relation between the inflammation and its product—between cause and effect. The inflammation first starts the purulent secretion, and it, in turn, perpetuates the inflammation. Thus otorrhœa is, to a considerable extent, *self-perpetuating*.

Chronic inflammation, then, is the direct cause of simple otorrhœa. But this is always preceded by an attack of acute inflammation in the meatus, which may be regarded as the indirect cause.

It will not be forgotten that the exanthematous diseases are the most common cause of acute inflammation in the external meatus (see Diseases of Meatus above). Hence, the history usually runs back to a time when the patient had one of these diseases, which he regards, and very correctly too, as the starting-point of the ear trouble.

As all classes are alike subject to the eruptive diseases, the inference is that all classes are about equally subject to discharges from the ears, which is found to be true in practice. As most of children have measles, which is the most frequent cause of acute inflammation in the meatus, very early in life, it would be expected that they would be particularly liable to have otorrhœa, which experience abundantly proves.

Scrofula (whatever that may be) is a predisposing cause of otorrhœa in both forms, and particularly so in children.

Injuries and foreign bodies in the meatus are exciting causes of simple otorrhœa.

Objective Symptoms.—The external meatus may be filled with pus, which occasionally is seen to drop from the ear when the suppuration is very profuse. Usually, however, the meatus is only partly filled with matter; sometimes it contains very little, only enough at the bottom to show the presence of pus. The character of the secretion is not uniform; it may be thick pus, or it may be mixed with a watery fluid; it always contains more or less epithelial scales from the epithelium of the skin.

When the pus is washed away, the skin of the meatus is very red, and sometimes a slight irritation with the probe causes it to bleed. The surface of the membrana tympani is likewise very red. Some portions of it are occasionally much redder than the general surface, as though there were points of circumscribed inflammation. These red points are mostly produced by fungous granulations on the surface of the membrane. Its outlines are not always well marked, most probably on account of the thickening of its external or skin layer. *Gruber* refers to this condition of the membrane as acute myringitis, which, as I think, is incorrect. I do not believe that the whole membrane is inflamed, but only its outer layer.

Sometimes polypous growths from the walls of the meatus, close down to the membrane, are discovered (see Polypi below).

Subjective Symptoms.—In the very beginning, during the acute inflammation, severe pain is complained of, which disappears as soon as suppuration sets in.

There is always more or less deafness according to the amount of obstruction from the presence of pus in the meatus and the extent of the thickening of the membrane. The patient rarely complains of noises in simple otorrhœa.

Diagnosis.—This is easy, as every purulent discharge from the ear is an otorrhœa. If there is no perforation of the membrane, through which the pus can come from the drum, then it must be simple otorrhœa.

Pathology.—As already intimated, the pathological condition in simple otorrhœa is suppurative chronic inflammation of the skin of the meatus.

Prognosis.—This, with treatment, is favorable, both with respect to the discharge and the improvement of hearing. The suppuration will cease entirely in from ten days to six weeks; occasionally, stubborn cases may continue longer than that.

Without treatment, the discharge will continue indefinitely; here and there a case will get well of itself, but that is only by way of exception. The reason of the rare recovery of otorrhœa without treatment, is certainly to be found in the *self-sustaining* or *self-perpetuating* nature of the disease, as already stated.

A marked improvement, at least in the hearing power, can always be promised. According to my experience, the hearing in nearly all cases will be completely restored.

Treatment.—This is simple and easy. Perfect *cleanliness* of the ear must always be insisted upon, as an essential part of successful treatment. The reason for this is very evident; the constant bathing of the parts in pus is a continued source of irritation, which is to be relieved by the proposed cleanliness. Otherwise, treatment is more than useless, for solutions dropped into the external meatus, while it is full of pus, can never reach the seat of the disease—can never get down to the suppurating surface. This shows the great importance of cleaning the ear well just before each treatment, in order that it may be most effectual. I insist upon this the more, because it is so *essential* to the success of the treatment.

For cleansing purposes I inject warm water (without soap) into the ear with a common hard rubber ear-syringe (see how to syringe the ear above). Some force is necessary in order to wash everything from the meatus.

Next to the cleansing comes the medication. What medicines shall be used? As a class, *astringents* are specially indicated; but, as their number is almost infinite, I select only a few of the best, as I think, from the mass.

Some of the German aurists prefer the vegetable astringents. This is not in accordance with my experience. I prefer, by far, the mineral astringents, which certainly act much more promptly. From these I select, as the very best, nitrate of silver and sulphate of copper. The first is more properly a caustic, but it has also an astringent effect. These are the leading remedies, and it is not often necessary to use anything else locally. Instead of the pure nitrate I am in the habit of using what is called *compound* nitrate of silver (equal parts of nitrate of silver and potassa). This is certainly as effectual and not so sharp, not so *caustic*, as the pure nitrate.

I always begin the treatment with about this prescription:

℞. Argenti nitrat comp., gr. xx to xl.

Aquæ distilat, ℥i.

Mix. Sig. Drop four or five drops into the ear twice a day, after *thoroughly* syringing it.

The medicine should be allowed to stand in the ear a few moments, so it will take full effect upon the diseased surface. The strength of the solution must depend upon the amount of the discharge and the age of the patient. For children the strength of the solution should range from 10 to 20 grs. of comp. nitrate of silver to the ounce of water. If pure nitrate of silver is used, the solution should be only half so strong for grown persons as well as children. In using the nitrate of silver, one precaution is necessary. The solution must never be allowed to run out of the ear and down over the face and neck, and perhaps on the clothing, as it blackens the skin, which looks ugly, and spoils the clothing. All this can be easily avoided by pressing a rag into the meatus, and holding it there with the finger, while the patient turns his head to that side far enough for the rag to absorb all the solution, and then the ear should be wiped dry. This little precaution will save the physician many a deserved scolding from his patients.

The nitrate of silver solution is to be continued in this way until the discharge ceases; after that it should be used for a few days, in order to prevent a relapse, but less frequently. The treatment should always be *gradually* suspended.

In case the use of the nitrate of silver does not materially lessen the otorrhœa in from three to four weeks, it should be suspended, and the following prescription be substituted:

℞. Cupri sulphat, gr. x to xx.

Aquæ distilat, ℥i.

Mix. Sig. Drop several drops into the ear twice a day after syringing it.

This is to be continued for ten days or two weeks, during which time the discharge will probably begin to subside. If it does not, then the two prescriptions should be alternated; one in the morning, and the other in the evening, and so on, until the discharge ceases.

In very stubborn cases, solutions of alum, zinc, or tannin, may be tried; they occasionally act very favorably.

The alum should never be used in powder, as is recommended by some of the German writers, for fear it will form hard concretions at the bottom of the meatus, which may be hard to remove. This occurred to me once in treating a little girl, and I had considerable trouble in removing the lumps. But the *chief* remedies are the silver and copper solutions, which, sooner or later, will prove to be sufficient. The greatest reliance is to be placed in the use of the nitrate of silver.

If the fungous granulations on the surface of the membrane, already referred to, do not readily disappear, they should be touched with the point of a probe, to which a little powdered compound nitrate of silver is sticking; but more of this under the head of polypi below.

Tympanic Otorrhœa.—I have already stated that the discharge, in this form of otorrhœa, comes from the mucous membrane of the cavity of the drum, and, in order to indicate that fact, I call it tympanic otorrhœa. The source of the pus implies necessarily a perforation of the membrana tympani, through which it passes into the external meatus.

Causes.—The original or indirect cause is acute inflammation of the tympanic cavity. It will be remembered that acute inflammation of the drum has several exciting causes, among which I may name acute pharyngitis (bad cold), the exanthematous diseases, and the various continued fevers. Acute inflammation may develop spontaneously in the drum, entirely independent of any other affection. Whatever its exciting cause may be, the acute inflammation progresses rapidly to suppuration, when the pus soon fills up the small cavity of the drum, and begins to press the membrana tympani outward. The pressure continues to increase on account of the continued accumulation, until finally the membrane either ruptures or ulcerates through, which usually takes place suddenly and with something of a crack (the people say the ear broke), and the matter discharges through the opening into the meatus. But just about the time the suppuration sets in, or pus begins to form, the acute becomes chronic inflammation, which perpetuates the suppuration. Chronic inflammation of the mucous membrane of the drum is, therefore, the direct cause of tympanic otorrhœa. The mucous membrane is constantly bathed in pus, which is always a source of irritation, and tends consequently to keep up or promote the inflammation. Hence tympanic otorrhœa is, to a great extent, *self-sustaining* or *self-perpetuating*, just as simple otorrhœa is.

Disease of the surrounding bone may give rise to suppuration into and discharge from the tympanic cavity.

Subjective Symptoms.—These are very similar to the subjective symptoms in simple otorrhœa. The history dates back to an attack of acute inflammation in the drum, when the patient had a *bad cold*, one of the eruptive diseases, or continued fever; at which time, as the story usually runs, the ear gathered, and, after severe suffering, broke, and the discharge has continued ever since. As soon as the membrane ruptures, the acute symptoms, such as pain, fullness, great deafness, noises, vertigo, etc., pass rapidly away, and the whole trouble becomes chronic.

There is always more or less deafness, according to the amount of the purulent secretion and the extent of injury to the membrane by the perforation.

Noises in the ear are not usually annoying in tympanic otorrhœa. The chief complaint on the part of the patient is the constant annoyance from the profuse discharge. "If I can only get rid of this discharge, I do not care so much for the deafness," is quite a common remark.

Objective Symptoms.—The meatus always contains more or less pus, which, in profuse cases, may even drop from the ear, or cause the patient to wipe his ear frequently. After the matter is syringed out, the perforation of the membrane can be seen. It is most frequently located in the posterior inferior portion of the membrane, though it may occur in any other part, and is of variable size, from a mere point to half or two-thirds of the size of the membrane. The mucous membrane of the drum has an unnaturally bright red appearance through the perforation. The external meatus and outer surface of the membrane have the same red appearance as in simple otorrhœa, in consequence of the irritation from the constant bathing of the parts in pus. There is no doubt more or less purulent secretion from the meatus, but that is always secondary to the suppuration in the tympanum.

The surface of the membrane may be dotted by red spots, like points of circumscribed inflammation, as in simple otorrhœa, and not unfrequently there is a red ring around the margin of the perforation. This always shows that the perforation is of recent origin. *Gruber* has described this condition of the membrane under the head of acute myringitis, which, as I think, is incorrect. There is no doubt inflammation of the membrane, but it is neither *acute* nor *primary*, but *passive*, being secondary, depending upon the original disease of the drum.

DIAGNOSIS.—If, upon inspection, after the ear is syringed clean, a perforation is visible, in which, most likely, a drop of pus is sticking that pulsates regularly, that is good evidence that the cavity is full of pus. The pulsations are caused in this way: Every time the heart contracts, the blood vessels of the tympanum fill up, and consequently reduce slightly the tympanic cavity. This presses the pus a little into the perforation, so that it is seen to rise and fall regularly with the heart's action. If the patient now forces the air through the tympanum by the well-known Valsalvian experiment, and a few drops of pus are seen to bubble with the air from the cavity of the drum, that settles the diagnosis. If the perforation is very small, and far toward the margin of the membrane, it may not be possible to see it. In such cases, the Valsalvian experiment will develop its presence, as well as its location, by forcing the air through it.

Finally, if necessary, the ear may be regularly inflated through the catheter. In this way, more force can be used; and, if a perforation is present, the wind will whistle through, driving, with a kind of cracking noise, the pus into the external meatus. This is positive proof that the pus comes from the tympanic cavity.

Prognosis.—Tympanic otorrhœa will continue indefinitely, if not treated, for the reason that the chronic inflammation is perpetuated by the constant bathing of the mucous membrane in the purulent secretion. With proper treatment, however, the prognosis is favorable. The discharge will cease sooner or later. The amount of improvement in hearing will depend upon the extent of the injury to the membrane. Some improvement can always be promised, but the exact amount can not be foretold. It is often surprising to see how perfect the hearing may become when there is even a very large perforation in the membrane.

The condition of the ossicles, of course, has an important influence on the final result. I may say, in general terms, that suppurative inflammation in the drum is much less likely to cause a stiffening of the chain of little bones, and a thickening of the membranes of the fenestræ, than catarrhal inflammation. As a rule, when the little bones are present at all, they are in a functionating condition.

Pathology.—The pathological condition in tympanic otorrhœa, as would be inferred from what has gone before, is chronic suppurative inflammation of the mucous membrane of the drum.

Treatment.—This differs from the treatment of simple otorrhœa only in the manner of applying the remedies. The necessity of perfect cleanliness is the same in this as in that; so I need not repeat here what was said there.

Before syringing the ear, it is well to have the patient blow the air through the drum, in the usual way, so as to drive out as much of the pus as possible into the meatus, so it will be removed by the water.

The ear being well cleansed, a solution of compound nitrate of silver (20 to 40 grs. to ounce) is to be dropped in (several drops at a time), and should be allowed to remain a little while. If it does not pass through the drum into the throat of itself, it should be worked through. This is easiest done by pressing the tragus gently down upon the fluid so as to force it to enter the drum, and thence through the tube into the throat. If the patient will swallow a time or two during the pressure, the medicine will pass more readily through. The patient will always know when it reaches the throat. The importance of bringing the solution into direct contact with the suppurating surface of the mucous membrane of the drum is evident to every one. Upon that will depend the success or failure of the treatment. To drop the solution simply into the meatus with the expectation of curing a tympanic otorrhœa is more than useless. The medicine *must* enter the drum and come into direct contact with the diseased membrane. I can not insist upon this too much. Every one, therefore, who expects to be successful in the treatment, must see to it that the solution enters the drum cavity.

The treatment never causes any serious pain; at least it has not in my experience. The solution should be applied twice a day and continued till the suppuration ceases; then once a day for a short time, then once in two days, and so on, gradually discontinuing the treatment. It should not be entirely stopped for some time after the suppuration has ceased.

Strong solutions are much more effectual than weak ones, but the caustic should, of course, never be sufficiently concentrated to destroy the mucous membrane. That would do *irreparable* damage.

The length of time required to cure a tympanic otorrhœa varies very much indeed. Sometimes a few days are sufficient, at other times it requires weeks and even months. The exact time can not be definitely foretold.

The only way to succeed is to persevere with the treatment, never forgetting the great importance of first cleansing the ear well, and then bringing the remedy into immediate contact with the diseased surface, and sooner or later success will crown the efforts.

Instead of the compound nitrate of silver, any of the astringents in moderate strength may be used in the same way. The sulphate of copper, in from 5 to 20 grs. solution, sometimes acts like a charm after the silver treatment has apparently failed.

Sugar of lead should not be used very long for fear of a lead deposit in the cavity of the tympanum.

Powdered alum should not be used, as recommended by some of the German writers, for the good reason that it forms sometimes hardened masses in the drum cavity or at the bottom of the meatus, which may be difficult to remove. Some years ago I had an experience of this kind in a child, and since then I have not used it at all.

Only a few words are necessary in regard to *internal treatment* in both simple and tympanic otorrhœa. In either case, if the patient is in good health, I give him no medicine internally, because there is no indication for it. If there is any cachexia, as scrofula, requiring medication, I direct accordingly. If there are any evidences, or even suspicions, of syphilitic trouble, anti-syphilitic treatment should be instituted at once. In that case the local treatment is less important and should be less energetic.

If the perforation in the membrane is not too large and not too old, it may heal after the otorrhœa ceases. If it does not heal of itself, no treatment will make it heal. I regard the repeated application of nitrate of silver to its margins, as recommended by many of the authorities, in order to make it heal, as injurious rather than beneficial.

If there is disease of the bone around the tympanum, which is certain only when the denuded bone can be felt with the probe, to keep the parts clean is about all that can be done. Time must be given for the diseased bone to exfoliate and come away, or be removed. The prospect in all such cases is somewhat unfavorable, as the bone disease may extend to the brain at any time and destroy the patient. It is impossible to stop the suppuration as long as the bone disease continues. The treatment by local applications, therefore, should never be severe. There is danger of trying to do too much rather than too little.

Both forms of otorrhœa are sometimes kept up by polypi in the meatus and in the drum. In such cases, of course, they must be removed (see Polypi below).

Blisters, or counter-irritation in any form, do no good in the treatment of otorrhœa. Severe purging is injurious rather than beneficial. Any considerable amount of dieting (starving) is not to be recommended.

Altogether, the results of the treatment of both forms of otorrhœa are, I may say, very satisfactory.

Remarks.—The physician must have courage and inspire his patient with courage, else he will never get through with a stubborn case of otorrhœa. The parents or nurse often neglect to cleanse the ear properly, as directed by the surgeon, and sometimes forget the treatment altogether. The physician, too, after some time gets careless, and does not enforce his orders in regard to cleanliness and regular treatment; and thus, as it were, by mutual consent of both parties, the case is *neglected*, if not abandoned. But too frequently the doctor is too glad to get rid of an offensive ear, while the nurse, perhaps, makes every effort to escape the trouble, not to say the unpleasant odor, that is always present in such cases, of washing and treating the unfortunate patient's ear. There is no doubt whatever that physicians, for this reason, *nearly always* fail to relieve the simplest cases of otorrhœa. Their negligence and indifference bring them into great disrepute among the people in reference to this particular subject. Hence it happens that a general practitioner is very rarely asked to prescribe for a running and terribly offensive ear, which often excludes a young man or young lady from society for a lifetime! Yes, even more; it may cause not only their total deafness, but also their death! Are the people at fault? Not at all. The profession at large must bear both the blame and the *shame*. Their negligence of aural diseases, in general, gives quacks one of their richest fields. The people will do anything and incur almost *any* expense to get rid of a *stinking* otorrhœa.

Vitally important as is this subject, very little is said about it in the medical schools. Long and tedious lectures are read to young men on how to ligate the common carotid or the internal iliac arteries, which, in all probability, not more than *one* in ten thousand of them will be called upon to do. But *very* seldom, *almost never*, are they told how to treat a common otorrhœa through to a successful termination, which *every one* of them will see and shrink from almost every day of his professional life. A distinguished professor used to say: "The medical profession is made up of small matters, and if we neglect these we miss its object and aim." Is not, then, a change in medical teaching demanded by the common wants of the profession, so that *small* matters, as they *seem*, may be referred to occasionally? As a medical student, I never heard the subject of otorrhœa mentioned.

But asking pardon for this digression, I return to the consideration of a popular and professional prejudice with respect to aural discharge.

Is it *safe* to check suddenly the discharge from the ear of long or short standing? This is a question among medical men, and it is surprising to see how many of them would give a negative answer. I do not know where it started, but certainly nothing is more unreasonable. Can disease be *safer* than health? Certainly not. How often do patients say: "Such and such doctors told us we must not stop the long-standing discharge; that would be dangerous. Let it alone; we will *outgrow* it." Strange doctrine and stranger advice! Otorrhœa gets well, without treatment, only by way of exception. For one, I am not afraid to stop any discharge from the ear; it is risky to let it run on indefinitely.

Aural Polypi.—These are fleshy excrescences, partaking of the nature of fungous granulations, that grow from the skin of the external meatus and from the mucous membrane of the tympanum. It is a question among the authorities whether they have their origin mostly from the tympanum or the meatus. My experience indicates that they grow more frequently from the former than from the latter.

Polypi in the ear present a bright red or flesh color, when not covered with pus or other secretions. Their surface is sometimes smooth, but more frequently it is covered with little prominences or granules, like the surface of a strawberry ; hence, writers frequently speak of strawberry polypus. In size, they vary from that of a pin-head to the full size of the meatus, which is sometimes completely filled by the polypous growth. They are usually pyriform in shape ; the small extremity, pointing inward, is attached, as a rule, by a small pedicle to the point of origin, wherever that may be. The outer extremity, which occasionally projects somewhat from the external meatus, has a roundish contour.

Causes.—The chief, if not the only cause of aural polypi, is chronic suppurative inflammation of the drum or external meatus. From this it will be inferred that they develop almost exclusively during the progress of simple or tympanic otorrhœa. This has been my experience. I do not remember a single case where there was even a probability that the polypous growth was the primary disease. *Troeltsch* states that he has seen two cases of polypi in the ear where no purulent inflammation had preceded. The almost uniform history of cases shows that in the very beginning there was an attack of acute inflammation in the meatus or drum, as the case may be, which subsided into chronic form, giving rise to otorrhœa (see its Causes and History above), some time during the progress of which the polypous growth took its origin. Hence, polypi are found almost exclusively in cases of long-standing otorrhœa. When they are once started, they become, in turn, a sustaining or perpetuating cause of the otorrhœa. In all such cases, the polypus must be removed before the otorrhœa can be cured. In fact, in some very stubborn cases of tympanic otorrhœa, in which no ordinary treatment seems to avail anything, there are good reasons to suspect the presence of a hidden polypus in the drum. I remember one case of the kind, in which a small portion of the polypous substance was visible under the edge of the perforated membrana tympani; with the point of a bent probe larger portions were easily brought into view.

Subjective Symptoms.—The patient, in all probability, will relate the history of the trouble, as just indicated.

The deafness is always in proportion to the size of the polypus and the amount of injury done to the membrana tympani. In most of cases, the deafness is very great; while in many cases there is total deafness, except by conduction of sound through the bones of the head. In other cases, again, the hearing may be quite perfect, where the polypus is not large enough to interfere with the passage of the sonorous vibrations through the meatus.

Noises in the ear are never a distressing or even a prominent symptom of aural polypi.

The greatest complaint on the part of the patient is from the annoyance of the discharge and the constant bad odor from the ear, which is often offensive, not only to himself, but also to his friends and associates.

Aural polypi are never painful, except, possibly, when they develop suddenly and rapidly.

Objective Symptoms.—The meatus contains more or less pus. There may be only enough to cover the surface of the membrane, or the meatus may seem to be full, and sometimes the matter is seen even to drop from the ear. The discharge is often tinged with blood, which is the most characteristic symptom of aural polypus. When the pus is washed away, the body of the polypus tumor is easily seen. It may fill the meatus entirely, or it may not be larger than a pea or a grain of wheat, deep down in the ear. It may be lying on the surface of the membrane, or it may be projecting outward, through a small perforation, from the cavity of the tympanum. The surface is usually somewhat nodulated (lobular) or strawberry-like. The color, as already stated, is a bright red flesh color. There are, however, varieties in color, depending upon the variety of the polypus. According to *Troeltsch*, a small polypus is always soft and red; but when it is large, so as to near the orifice, or even protrude from it, its surface becomes covered with a dense kind of non-suppurating fibrous membrane. This change, if *Troeltsch* be correct, is most likely brought about by the effects of the atmosphere.

All red polypi are very soft and excessively tender. They bleed profusely upon the slightest touch; hence the frequent appearance of blood in the discharge.

There are often two or more polypi, with distinct pedicles, in the same ear. There is no regularity about the point of attachment of the pedicle or pedicles. That may be anywhere on the walls of the inner half of the meatus (I have never seen one attached in the outer half), on the surface of the membrane, or within the cavity of the drum, as has been remarked already.

The skin of the meatus is usually quite red from the irritation of the polypus and pus; or the meatus may be unusually large, being dilated by the pressure, if the polypus is very large.

As I have stated in another place, the surface of the membrana tympani is occasionally covered by points of fungous or polypous granulations. These may be regarded as incipient polypi, at least the fungous granulations partake of the same nature, and for that reason they are often called polypous granulations.

PATHOLOGY.—Until very recently the pathological change in the polypous growths was supposed to be circumscribed hypertrophy of the mucous membrane; but this generally accepted theory has been disproven by the fact that polypi frequently grow from other structures as well as from mucous membranes. They are, therefore, not the product of mucous membranes alone; hence the real pathology of aural polypi is not yet settled, the former ideas in regard to the matter having proven incorrect. There is, however, a polypus, which results from hypertrophy of the mucous membrane of the drum, but that does not at all account for the polypi that grow from the skin of the external meatus, which differs essentially from mucous membrane.

Heretofore the term *polypus* has had a very wide application. All pendulous or pediculated growths from any mucous membrane have been designated polypi. Confusion necessarily follows such indiscriminate and unwarranted use of the word.

According to *Erichsen* (see Science and Art of Surgery, 1873), true polypus is composed of the elements of mucous membrane in a state of hypertrophy, while growths, not composed of these elements, are other forms of tumor covered by mucous membrane. Of these, *Gruber* has mentioned and briefly described three varieties that occur in the drum: 1. *Myxoma*, in which cell-structures seem to be in excess. Some authors regard this as a variety of polypus. 2. *Fibroma*, in which the fibrous element prevails. 3. *Adenoma* is supposed to originate in diseased gland; at least it is largely composed of glandular elements, from which fact it gets its name.

But the future will have to determine the definite pathology of polypus in general, and consequently of aural polypus.

Diagnosis.—The characteristic appearance of a polypus in the ear renders its diagnosis quite easy. After the pus is syringed away, the polypous tumor can be easily seen. If the growth is small, it will appear deep down in the ear at the bottom of the meatus; if it is large, it will fill up the meatus, and possibly project somewhat externally. When the tumor is touched with the probe, it will be found to be very soft, and the slightest force will make its surface bleed profusely. That, at least, will be the case when the growth is true polypus, but if it is one of the polypoid growths, already mentioned, the body of the tumor will be firmer, and much less disposed to bleed.

To find the point of attachment, the pedicle, it is only necessary to run the probe around the tumor between it and the walls of the meatus. The point where the probe is checked indicates the seat of attachment. If the probe passes entirely around the body of the polypus without interruption, the inference is that the pedicle is near the membrana tympani, on its surface, or, what is most probable, it grows from the cavity of the tympanum.

The most reliable symptom of aural polypus is a repeated bloody discharge from the ear. I have never met with such a symptom where there was no polypus.

The fetor from aural polypus is specially disagreeable; but there is uniformly more or less bad smell about a suppurating ear, whether it is simple, tympanic, or polypous otorrhœa.

Prognosis.—So far as the polypus is concerned, the prognosis is favorable. That can always be radically removed so it will cease to grow. The length of time required to effect the cure varies all the way from a few days to twelve months. The most difficult cases are those where the pedicle grows from the cavity of the tympanum, making it difficult to reach it.

The hearing may be entirely restored, when the polypus grows from the meatus and the membrane is uninjured. On the contrary, the prospect is not good when the pedicle grows from the tympanum, which necessarily involves more or less injury of the membrane. In such cases, its removal may improve the hearing, but complete restoration can not be promised.

The otorrhœa, depending upon the polypus, will cease soon after itsr emoval. If it does not, the ordinary treatment for otorrhœa will soon stop it.

Treatment.—This consists in the removal of the polypus thoroughly and completely. The ingenuity of every surgeon will suggest to him the best means of accomplishing this. Any instrument with which the operator can most conveniently get hold of the polypous tumor so as to twist or tear its pedicle off, is the one he should use. Experience teaches that the most appropriate instrument for this purpose is what is known as Wilde's polypus-snare (see Fig. 24). The noose is made large enough to encircle the body of the polypus, and is then passed over it and worked down as near the pedicle as possible ; the noose is then tightened by drawing the cross-bar, to which the wire is fastened. In this way the the noose is made to cut through the polypus, bringing away all external to the point of stricture.

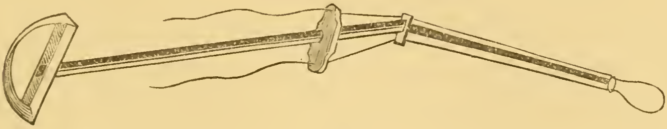

Fig. 24.

Considerable hemorrhage follows, but it soon ceases. After the bleeding stops, the blood should be syringed away, and, if the remaining portion of the polypus is large enough for a new hold, the snare should be reapplied, as before, and another piece brought away, and so on, till the entire polypus is gone, or as much as it is possible to get hold of with the snare. Sometimes the operator will succeed in removing the entire polypus the first attempt, then again it will require several efforts, and occasionally portions are so deep-seated that it is impossible to get the noose down to them. Very small polypi at the bottom of the meatus and those that grow from the tympanum, which often do not project beyond the surface of the membrane, can not be reached by the snare. These small polypi, together with the remains of those removed with the snare, I am in the habit of picking away, *piecemeal*, with a pair of toothed forceps. For this purpose I use *Græfe's* common fixation-forceps, which answer the purpose as well as any instrument I have ever seen. If these were more slender, they would be still better. With them I pick or tear off successive portions of the polypus, until the pedicle is reached or all accessible parts are

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Fig. 24.—Wilde's polypus-snare.

gone. After this the pedicle and remaining portions are to be cauterized till all traces disappear.

Some of the authorities have a horror of using forceps in removing polypi from the ear. When *blindly* used they are very dangerous, but, when *properly* used, they are perfectly safe and very valuable. I always pass them in through a speculum, the ear being constantly illuminated with the mirror, so I can see exactly where the forceps are going and what they are taking hold of. It is not often necessary to cause even a drop of blood to escape from the skin of the meatus, much less tear pieces out of it, or to injure in any way the membrana tympani. All that is necessary is for the operator to see exactly what he is getting hold of. This is a delicate manipulation, but a very successful one, when properly executed.

After all has been removed that it is possible to get hold of with the snare and forceps, the caustic is to be applied to what is left. For this purpose, I prefer the compound nitrate of silver in powder. I shave down a little of the stick with a knife, so as to make a powder. I wet the end of a silver probe just a little, and stick it into this powder; a small portion sticks to the probe, which I now pass through the speculum, always illuminating the parts with the mirror, and touch it to the pedicle or remains of the polypus. The moisture dissolves the powdered silver readily, and causes it to spread over the entire denuded or polypous surface, which is thus effectually cauterized. This should be repeated once a day till all traces of the polypus disappear.

I prefer to use the probe in this way to any caustic-holder I ever saw, because it is convenient, easy, effectual, and much slenderer than any of the ordinary caustic-holders, and consequently is much less obstructing to the view.

I much prefer to use the caustic in substance, because it can be confined to the point where it is most needed. If a solution is used, the whole surface of the meatus and drum is cauterized at the same time, and equally severely so as the point from which the polypus grew.

I use the compound nitrate of silver in preference to the pure, because, as a rule, it is not painful. The pure nitrate is a little *too caustic* for this purpose, as it occasionally causes quite severe pain. It may, however, be used in the same way as the compound nitrate.

It has been proposed to destroy aural polypi from the first with the severe caustics, as Vienna paste, chloride of zinc, etc. Such treatment is not to be thought of even, as these caustics, not being limitable in their action, would destroy not only the skin of the meatus, the mucous membrane of the drum, and, in all probability, the membrana tympani, but also the periosteum, which would seriously endanger the bone. Such severe caustics should never be resorted to.

When there is considerable polypous substance left after the use of the snare and forceps, it is well to work the caustic into it somewhat with the point of the probe, which would hasten the matter along considerably. Particularly is this the case when the drum cavity contains a small polypus which has to be removed entirely by the medicine; hence the necessity of working it well into the drum. Such cases prove usually to be very tedious at best.

The more powerful astringents, such as persulphate of iron, perchloride of iron, etc., may be used instead of the compound nitrate of silver, but the caustic is more effectual.

Fungous or polypous granulations on the surface of the membrana tympani are to be destroyed by caustic, applied with the probe or otherwise, as may be most convenient.

After all traces of polypous substance and polypous granulations are gone, if the otorrhœa does not cease, it is to be treated as an ordinary otorrhœa (see above).

Usually the use of a solution of compound nitrate of silver (20 to 40 grs. to ounce of water), for a few days, is sufficient to stop it. A solution of any of the more active astringents may be used instead of the silver solution. Under no circumstances should the treatment be discontinued before all suppuration has ceased, as the polypus might grow again. This is sure to be the case, if it is not thoroughly removed. It sometimes requires great patience on the part of the physician, as well as the patient, to stick to the treatment long enough to destroy a small polypus that is hid away behind the membrana tympani, in the cavity of the drum. Sooner or later stubborn perseverance will be crowned with success.

ACCUMULATION OF SERUM IN THE TYMPANUM.—*Politzer* first diagnosed and described a collection of serum in the tympanic cavity. Since then other writers have observed cases of it. The following is a short synopsis from *Politzer's* description in his "membrana tympani in health and disease:"

SUBJECTIVE SYMPTOMS.—Sudden deafness of a pretty high degree in one or both ears, accompanied by noises and a feeling of heaviness and pressure about the ears and through the head. Noises from without sound distant, and the patient's voice rings through the ear. The deafness varies; sometimes better, and at other times worse. Sudden cold seems to be the exciting cause; at least the history indicates that.

Objective Symptoms.—The membrane (in the case described) was unusually transparent and considerably sunken. The upper half presented a lighter color than the lower half, which was a darker gray. The boundary between the two portions was indicated by a fine black line, concave above, running horizontally across the membrane, looking like a black hair on its surface. In the recumbent position, this line changed to a horizontal direction, showing that the line was caused by fluid in the drum. The vessels along the manubrium were decidedly injected. There being no question about there being fluid in the drum, the ear was inflated by *Politzer's* method. The membrane bulged outward slightly, and instantly the single black line disappeared and numerous black rings, of various sizes appeared, which seemed to cover the entire membrane. These rings, as *Politzer* explains, were air-bubbles in the drum, caused by the inflation. Previous to this observation, *Troeltsch* had seen "mucous bubbles" in the drum.

The inflation was followed by a striking improvement in both hearing and head symptoms, as also in the noises. The cracking noises, heard soon after the inflation, were supposed to be caused by the movements of the air-bubbles in the drum.

The following day the amount of fluid had diminished considerably, as shown by the black line being much lower. The treatment consisted in inflation every other day. In three weeks the patient was discharged well.

The cause of serous accumulation in the drum is not understood. The mucous membrane of the drum, according to *Politzer*, secretes, in a normal condition, some serum. When the Eustachian tube is closed, the serum accumulates. If that is the case, accumulation should take place whenever the tube is closed; such, however, is not true in practical experience.

After a fair trial of inflation, if the improvement is not satisfactory, *Politzer* recommends paracentesis of the membrane, so as to evacuate the serum into the meatus.

Dr. Moos has observed several cases of serous accumulation in the tympanum, and performed paracentesis in most of them with fair results.

The treatment by inflation should be thoroughly tested before an operation is resorted to. In most of cases that will afford prompt relief. During the act of inflation, the patient should incline his head to the opposite side and a little forward, as *Politzer* suggests, so as to facilitate the escape of the fluid into the throat.

It would naturally be supposed that the black line, indicating the surface of the fluid in the drum, would be *straight*. Its slight concavity upward is probably caused by *capillary attraction* in the margin of the drum cavity.

DANGERS OF INFLAMMATORY DISEASES OF THE MEATUS AND DRUM.—It will be remembered that the skin and periosteum of the meatus, particularly down close to the membrane, are so closely connected that it is difficult, if not impossible, to separate them. They may, therefore, be regarded as a single structure. Every acute or chronic inflammation of the meatus consequently is, at the same time, an acute or chronic periostitis. So, also, is the lining membrane of the drum a compound structure; the inner surface has the characteristics of, and is, a mucous membrane, while the outer surface is the periosteum of the surrounding bones. Every acute or chronic inflammation of the drum is consequently an acute or chronic inflammation of its periosteum. The foregoing pages show how frequently acute and chronic inflammations of the meatus and drum take place. By inference, acute and chronic periostitis of these parts is just as frequent. Aural catarrh involves the periosteum in similar inflammation; so does every case of simple or tympanic otorrhœa affect similarly the corresponding periosteum. At least that is the inference drawn from the intimate anatomical relations of the parts.

The periosteum is the source of nourishment to the bone. Long-continued disease of the periosteum, therefore, is very liable to cause disease of the bone, more especially *caries* or *necrosis* (see below). Experience teaches that disease of the corresponding bones is comparatively rare. The wonder is that it is not much more common than it is, considering the immense number of inflammatory aural affections through the country.

The people think, and physicians encourage the notion, that diseases of the ear are perfectly safe so far as life is concerned. On the contrary, there is a very considerable risk in every inflammatory disease of the ear, more particularly of the drum. As long as it persists, no one can tell what the result will be. The serious head symptoms that often accompany aural diseases have been referred to repeatedly in the preceding pages. The aural disease may extend to the brain at any time, and suddenly carry off the patient. The close anatomical connection (by blood vessels) between the tympanum and the brain favors very much the formation of a metastatic abscess within the cranium in connection with disease of the drum. Experience shows that abscesses not unfrequently form in the brain as complications of diseases of the ear. In fact, the brain trouble usually assumes the form of a so-called metastatic abscess.

Some years ago I treated a gentleman for repeated attacks of otorrhœa, which would get apparently well and then return again. Finally, he was attacked suddenly with severe head symptoms and died after several days of intense suffering. An autopsy was not permitted, but I have no doubt but there was an abscess formed in the brain. I have heard of a number of other similar cases through medical friends, outside of the recorded reports of such cases.

Otorrhœa, therefore, is by no means a perfectly harmless disease so far as danger to life is concerned. It not unfrequently proves fatal in the way I have just mentioned, and the sooner the people get to understand the danger of such a disease the better. Physicians assume a heavy responsibility in telling people there is no danger in such cases.

The danger to life from otorrhœa is particularly great in small children, in whom the communication between the tympanum and cranium is closer and more direct. The easy possibility of fatal results should admonish every parent not to neglect an otorrhœa in his child.

Caries and Necrosis of temporal Bone.—These diseases are observed much more frequently in the temporal bone than any other one of the cranial bones. The seat of the caries and necrosis is usually in the petrous portion of the bone and in the parts adjacent to the cavity of the tympanum and the external meatus and in the neighborhood of the mastoid cells (see below).

This shows that the origin of these diseases is often to be found in affections of those cavities. Such would be the natural inference from what has already been said in regard to the frequency of periostitis, the usual exciting cause of caries and necrosis, in connection with acute and chronic inflammation of the tympanum and meatus. These affections of the ear, then, must be regarded as the producing cause of the diseases of the bone, and among them long-standing otorrhœa, either simple or tympanic, may be mentioned particularly as the most common exciting cause of the bone trouble.

Such a bone complication is one of the dangers to be apprehended in otorrhœa, as I have already intimated; the possibility of such serious complication is another good reason why its treatment should never be neglected.

Caries and necrosis may develop spontaneously in the substance or on the surfaces of the temporal bone, which, however, is rare. Injury may cause disease of this bone, but that is likewise rare.

Scrofula, syphilis, and tubercular cachexia are exciting and producing causes of caries and necrosis in all the bones, the temporal bone being no exception to the rule.

Diagnosis.—It has been said that disease of the bone could be detected by the peculiar odor of the ear. This is a mistake, as the smell in simple or tympanic otorrhœa is very similar, not to say identical, to that from diseased bone.

If denuded bone can be felt with the probe, that is positive evidence that there is disease of the bone. In using the probe in the ear, no force whatever is to be exerted, for fear of injuring important parts which lie close to the tympanum on every side. Escape of small particles of bone in the discharge is also positive evidence of bone disease.

Total or partial paralysis of the facial nerve is confirmatory evidence of disease of the bone, which has reached and involved the body of the nerve somewhere in its course through the petrous portion of the temporal bone. But according to *Troeltsch*, facial paralysis may be produced by the pressure of a polypus in the drum or by tympanic otorrhœa.

In such cases, the facial paralysis disappears when the polypus has been removed and the otorrhœa cured.

It is more likely to be persistent when it depends upon disease of the bone, and may continue even after the bone is healed, depending upon whether the healing process causes any permanent pressure upon the trunk of the nerve.

PROGNOSIS.—The ulcerative process in the bone may penetrate some of the important blood vessels in the neighborhood of the tympanum at any time, and cause fatal hemorrhage. *Troeltsch* refers to cases of the kind, and the common carotid, according to him, has been successfully tied a number of times to stop such a hemorrhage. The prognosis, therefore, in caries and necrosis of the temporal bone, is, to say the least, unfavorable, not that the disease will necessarily prove fatal, but it *may* carry the patient off at any time.

Besides the danger to the blood vessels, the bone disease may penetrate the cranial cavity and excite acute meningitis or cerebritis, or a metastatic abscess may form in the substance of the brain.

TREATMENT.—This must be *expectant* rather than *active*. The parts should be kept clean, and pus should not be allowed to collect and remain in any portion of the ear. A free escape of matter from the diseased point in the bone is to be kept up, under all circumstances, as that will lessen somewhat the danger of brain complication. Time must be given for the bone to exfoliate and come away. The removal of the diseased bone by a surgical operation, as would be done in other parts of the body, is impracticable, on account of difficult access to the part; besides, such an operation would be hazardous in such close proximity to the brain.

When a sequestrum forms it should be removed immediately. The physician should not be too meddlesome in such cases, and *try* to do too much.

The little bones of the ear sometimes come away during the process of exfoliation of the carious or necrosed bone. In fact, they are occasionally the seat of such diseases.

Internal treatment is to be directed according to general indications. If the patient is in good health, he needs no internal medication.

MASTOID CELLS.—These constitute a part of the middle division of the ear, and communicate directly with the cavity of the tympanum by one large irregular opening, or several small ones (see Anatomy above). This close connection makes the mastoid cells participate largely in the diseases of the drum, more particularly its acute diseases. Primary affections rarely develop in the mastoid cells.

ACUTE INFLAMMATION is the most common disease observed in the cavity of the mastoid process. This usually accompanies or follows closely upon an attack of one of the exanthematous diseases; its most frequent cause, therefore, is the same as that of acute inflammation of the drum. Such would be a natural inference from the fact that the same mucous membrane lines both cavities. Occasionally it develops in connection with otorrhœa, and then again, as already stated, it may be primary, though that is rare.

Acute inflammation in the mastoid cells, as in the tympanum, progresses rapidly through the congestive stage to suppuration, which causes the formation of a

Mastoid Abscess—a collection of pus in the mastoid cells.

As soon as the original acute inflammation sets in, severe pain begins in and around the ear, and often extends to the whole side of the head. This grows worse, as the inflammation advances, and when suppuration takes place and the pus distends more and more the bony walls of the mastoid cavity, the suffering becomes intense. At this stage, the subjective symptoms often resemble those of acute diseases of the brain. Very soon, however, the surface of the mastoid process begins to show signs of the acute disease within the bone. The skin begins to get red and swells, and becomes tender to the touch, as also the bone beneath it. These symptoms increase rapidly as the process goes on. In from one to six days, fluctuation, as a rule, can be felt, except, possibly, in rare cases, where the outer plate of the mastoid cells is unusually thick and hard—*eburnated.* If let alone, the matter, in a short time, will break through the skin and discharge externally; or it may open into the external meatus; or it may discharge through the tympanum into the meatus.

When otorrhœa has preceded the attack, it usually ceases during the acute inflammation in the mastoid cells. Hence, persons (including many physicians) often say, "The disease has *struck in.*" This is one of the false arguments against checking otorrhœa on general principles.

Treatment.—This must be *surgical.* As soon as there is sufficient evidence to establish the diagnosis, the abscess should be *freely* opened. The incision should be from one to two inches long, and should be made clear down to the bone. The swelling sometimes makes the overlying tissue very thick, but the knife should be made to penetrate it all. The cut must, of course, pass through the point of greatest swelling, but its direction should be vertical; that is, it should be about parallel with the posterior part of the auricle, taking care always to avoid the posterior auricular artery, which runs close behind the auricle. It is very important to open the abscess *freely*; if a single incision is not sufficient, a crucial incision should be made.

If the matter has already reached the surface of the bone, it will discharge at once. If, however, the pus has not yet made its way through the substance of the bone, that should be penetrated, so as to give immediate escape to the matter. The bone, under such circumstances, is usually soft, so it can be penetrated with the handle of the knife or with a large-sized probe. If these fail, then cutting instruments, such as bone-chisel or trephine, must be employed. With these the outer bony layer or plate of the mastoid process is slowly perforated. I say *slowly*, because this operation should never be made with a rush, for fear of going too deep and doing damage. It is only necessary to penetrate the outer wall of the mastoid cavity, and the instruments should never be allowed to enter it any distance, as the brain and other important structures are in close proximity. The only object is to give free vent to the collection of matter; when, therefore, an opening is made into the mastoid cavity, the operation is done.

The importance of an early and free opening in mastoid abscesses can not be overestimated. There is great danger to life. The pus presses equally in all directions. If the internal plate of the mastoid process should happen to be thinner and more porous than the external, the abscess would naturally break inward into the cranium, which would prove inevitably fatal. Then, again, there is danger from the close vascular connection between the two cavities. Again, the collection of pus is likely to cause caries or necrosis in the mastoid process. If the matter is allowed to collect beneath the periosteum, after it has penetrated the bone outward, it may cause extensive detachment of that membrane from the bone. A serious form of necrosis may follow such an interruption of the nutrition to the bone. I remember one case, where the pus seemed to have separated the periosteum from the whole side of the head.

To avoid all these dangers and to save the patient suffering, early and free incisions must be made. The opening should be kept open and a free discharge of pus secured. If necessary, the mastoid cavity may be syringed out with warm water often enough to keep it clean. Usually the discharge ceases in a few weeks. If it should not, however, mild astringents may be injected into the mastoid cells.

If caries or necrosis is detected, time will be necessary for the bone to exfoliate. Whenever a sequestrum is detected, or small loose (detached) pieces of bone are found, they should be removed immediately.

The hearing is usually permanently injured by a mastoid abscess; sometimes it is totally destroyed.

TREPHINING MASTOID IN DOUBTFUL CASES.—Cases of serious trouble about the ear occur, where it is doubtful whether the disease is in the mastoid cells or in the brain, the symptoms being very similar in each. In all such cases, if a reasonable probability of mastoid disease can be established, there is a proper indication for trephining the process, which should be done at once. A little delay may prove fatal to the patient by the disease (purulent collection) extending or breaking inward into the cranium. A previous tympanic otorrhœa, with sudden development of severe pain in and around the ear, accompanied with more or less brain symptoms, is good, although not conclusive, evidence that acute inflammation of the mastoid cells has set in. It is also true that secondary disease of the brain may develop, as suddenly, in connection with tympanic otorrhœa. A differential diagnosis is, therefore, very difficult to make, I might say impossible, before there is local evidence of the mastoid trouble on the surface of that process.

A doubtful case of this kind occurred some years ago in the hospital practice of *Dr. E. Williams*, of Cincinnati, the details of which I extract from a private letter.

A man, otherwise healthy, had had persistent tympanic otorrhœa for some time, in the course of which severe pains in and about the ear came on. These continued, without intermission, for weeks, and were so severe it seemed as though the patient could not survive the suffering. All kinds of treatment were tried without effect. Hypodermic use of morphine gave only very temporary relief. It was impossible to tell whether the pain was caused by disease of brain or mastoid cells. In the course of the suffering, facial paralysis on the corresponding side came on. Finally, some little swelling and slight tenderness to pressure were observed over the mastoid, whereupon the trephining was at once determined upon. A free incision was made down to the bone; its outer plate was trephined through. When the instrument entered, or rather reached the mastoid cells, a little turbid fluid escaped, but no pus. In two or three days, however, pus escaped freely from the mastoid cavity, and the man made a good recovery. The operation *probably* saved his life.

I repeat again that, in such cases, where there is reasonable probability that the trouble is in the mastoid cells, the process should be trephined without delay.

It may become necessary to trephine the process in order to remove a sequestrum from the interior, as *Troeltsch* remarks.

The history of the operation shows that there is very little danger connected with it. Of course care must be taken not to penetrate too deep.

PERFORATIONS IN THE MEMBRANA TYMPANI.—The preceding pages show that perforation of the membrane most frequently occurs in connection with acute inflammation of the tympana; consequently it generally follows an attack of one of the acute exanthematous diseases. In fact, it may be regarded as one of the sequela of these diseases. They occur mostly in the lower half of the membrane, though they are not confined to that part.

Fresh perforations are always disposed to close, but by the time the original or producing disease is well, their margins, as a rule, are completely healed over. The mucous membrane, from within, and the skin, from without, draw together and cover the raw edges, so as to prevent the healing process. Hence it is that *old* perforations rarely heal. Can they be made to close? In my judgment, no effort should be made in this direction. If they do not close spontaneously, I do not try to make them close. To relieve as quickly as possible the producing disease, puts the membrane in the best possible condition to heal. When that is done, all is done.

I am well aware that some of the authorities advise the application of lunar caustic to the healed-over margins, in the hope that granulations will spring up and cause the membrane to cicatrize. I doubt the propriety of such treatment. I have never seen any good result from it. *Troeltsch* thinks it increases the openings rather than closes them.

Some advise paring the edges with a knife, so as to make them fresh. Others advise repeated incising of the edges of the perforation, in order to make them heal. The propriety of all this is very doubtful indeed. I do not advise any effort to be made in trying to cause an old perforation to heal.

Artificial Membrana Tympani (artificial drum).—Hundreds of years ago, it was thought that a very small perforation in the membrana tympani caused a high degree of deafness, and larger ones proportionately greater deafness. This idea led naturally to the consideration of the possibility of improving the hearing by closing the openings with artificial membranes. This was the starting-point of artificial drums, and several kinds were soon introduced to the notice of the public.

As is well known, *Toynbee* has the credit of introducing the artificial drum to the favorable consideration of the profession more recently, and claims that it was an original idea with him, although others had used it before him.

Toynbee's artificial membrana tympani is simply a gutta-percha disk, less in circumference than the natural membrane, with a silver wire about an inch in length passed through its centre. The object of the wire is to facilitate the introduction and removal of the instrument. The artificial membrane, when in position, lies on the surface of the natural membrane, and is so placed that it covers over the perforation. Its effect upon the hearing is sometimes wonderful. There is, however, a very serious objection to the use of *Toynbee's* artificial drum. It irritates too much, and, by its weight, presses too much upon the membrane, and at times causes considerable pain. The longer it is worn, the more trouble it causes, until finally the patient may have to lay it aside entirely. *Yearsly* has suggested the use of wads of cotton for artificial membranes. *Troeltsch* thinks that the cotton forms an excellent substitute for *Toynbee's* gutta-percha drums. In this opinion, I agree with him fully.

The cotton costs nothing, has no weight, irritates but little, causes no pain, and answers the purpose just as well, if not better, than the artificial membrane recommended by *Toynbee.* The cotton wad or drum is made by squeezing a small bit of cotton so as to make it flat, with a circumference of about one-half or two-thirds the size of the natural membrane. This is introduced with a hair-pin, a match, or probe, down to the bottom of the meatus, and is made to fit nicely to the surface of the membrane. A little practice enables a patient to introduce and remove it with great ease. If thought best, a fine sewing-thread may be tied around the cotton, so as to hold it together better.

I wish to refer very briefly to a couple of cases, to illustrate the way in which the cotton is used.

Case No. 1.—Miss T——, æt. 23, of Kentucky, apparently in good general health. When a little girl, she had an attack of what her physician thought was inflammation of the brain, but a discharge from her ears took place suddenly, and all brain symptoms disappeared. The resulting tympanic otorrhœa subsided with proper treatment, but her hearing remained very imperfect. A friend told her to put cotton wads into her ears, and see if they would not improve her hearing. She tried the cotton, and persevered in the trial, till finally, after several days' effort, she learned to place the wads in a certain position, where they improved her hearing so much that it was almost, if not quite perfect. Since then she has worn the cotton pellets constantly. She syringes them out in the evening, and puts fresh ones back with a hair-pin in the morning. Without the cotton she can hear the watch about half an inch; with it, she hears it two feet. When she first succeeded in placing the cotton on "*the right spot*," ordinary sounds became so loud they were painful to her. The rustling of a silk dress, a thing she had not heard for many years before, was quite unpleasant to her.

Her object in consulting me was to find out if she could not have her ears fixed so she could dispense with the cotton. She was afraid it might injure her.

Upon examination, the following condition was found: An elliptical perforation of moderate size near lower margin of right membrane. The mucous membrane of the drum was somewhat red. The air would pass through very rapidly by the Valsalvian experiment, and neither mucus nor pus came from the drum. The membrane of the left ear was whole, the perforation having healed, as indicated by the cicatrized condition of its central portion, giving its surface an uneven appearance; the whole seemed to be pressed inward. Both ears could be easily inflated through the catheter.

The ear with the perforation was most improved by the cotton pellet, but the other was decidedly benefited by it. It was extremely interesting to observe the position of the cotton when it was "on the right spot." That spot seemed to be about the centre of the membrane, that is, over the handle of the malleus, in each ear. To determine this point, I examined both ears closely after the patient had placed the cotton correctly. It occupied the same position in both.

Case No. 2.—Mrs. B——, also of Kentucky, æt. 33; has good health. When a little girl, she had an attack of acute inflammation of the cavities of the drums. The membranes ruptured, and the otorhœa continued for some time, and ceased spontaneously. She came to see me on account of tympanic otorrhœa in her child. She incidentally called attention to her own ears, and, upon examination, I found a large central perforation in the right ear, involving nearly half of the membrane. In the left ear there had been a perforation, but it had healed, as the cicatrized membrane showed. In her right ear, she had been wearing a cotton wad for several years, which made her hearing quite perfect. Without it, the watch had to touch before she could catch the ticking. With it, she could hear it two and a half feet, about the ordinary distance.

At first, as in case No. 1, she had to learn to place the cotton "*on the right spot.*" Somebody in her neighborhood first told her to wear it, and she had to work for several days before she could strike the spot. When she did once succeed, ordinary sounds became suddenly so loud that they were painful to her, so that she had to shun, for a time, anything like loud noises.

She puts the cotton in and takes it out with a hairpin, and sometimes she has to move it a time or two before she gets it to the right place. When it improved her hearing most, its position seemed to be about the centre of the perforation, which corresponded to the centre of the membrane. In the left ear, where there was no perforation at time of examination, the cotton was of no service; besides, it caused her some trouble. She puts in fresh cotton once in twenty-four hours, so as to keep it clean. She presses the cotton into a lump, and moistens it, before she puts it in. Case No. 1 always tied a thread tightly around the wad, moistened it, and then introduced it.

General Remarks.—The size of the wad, as already stated, should be considerably less than the membrane, and should lie flatwise upon its surface. A trial is necessary to tell whether it will benefit the hearing or not. It is impossible to tell beforehand what effect the cotton, or any other artificial membrane, will have. Sometimes it takes several days to make the cotton, or whatever else is used, strike "*the right spot*," as was the case in both patients just reported. Most persons would give up in despair long before they have made a sufficient trial. I am satisfied that, if physicians and patients would exercise more patience in properly testing artificial drums, they would be found much more uniformly beneficial. The difficulty experienced by both of the above cases in getting the cotton wad properly located, proves this statement. It is a curious fact, that these two ladies, living within fifty miles of each other in Kentucky, should arrive at the same practical use of the cotton wad, as an artificial membrana tympani, without having any knowledge of each other, and without the advice of any medical man. It must be remembered, that these ladies first began to use these wads some sixteen years ago, when artificial membranes, in this country, were very little known.

The modus operandi of artificial drums is not definitely settled. *Toynbee's* idea, that, because they closed the perforation, they improved the hearing, has been proven to be incorrect. Numerous cases have been reported, where the artificial drum improved the hearing remarkably in ears where there was no perforation. One ear in case No. 1, in which there was no perforation, was much improved by the cotton wad. The perforation in the other ear was so far to the margin that the cotton could hardly cover or close it.

Yearsley's idea, then, is probably correct, that artificial membranes act by supporting the chain of little bones. He supposes that some one or more of the joints may be loosened or separated by the previous disease; the weight of the artificial drum presses the ends together, which position is essential to the conduction of sonorous vibrations to the labyrinth. This is the most reliable explanation of the action of artificial membranes. Many facts seem to sustain this view of their action.

Troeltsch accounts for their action on a similar hypothesis.

When the central part of the membrane is destroyed, and possibly the malleus and incus carried away, the artificial membrane may come in direct contact with the outer end of the stapes, and thus communicate the vibration to the labyrinth, as appeared to be the case in the right ear of case No. 2 above.

I believe, as I have already stated, that a more extended and persevering trial of artificial membranes, particularly the cotton, would prove them to be more generally useful than at present.

They should not be worn, as a rule, during the progress of an otorrhœa. That should be cured first, as the foreign substance would, in all probability, aggravate the trouble.

LABYRINTH.

This is the internal part or third division of the ear, the part to which the auditory nerve is exclusively distributed, and is therefore the hearing apparatus, the point where the first impression of sound is received. All the parts, external to this, are necessary mechanical arrangements, as it were, for the conduction of sound to the point of ultimate distribution of the auditory nerve.

ANATOMY.—The labyrinth is situated just internal to the cavity of the tympanum, separated only by a thin bony partition, and seems to be a kind of excavation in the solid part of the petrous portion of the temporal bone. Anatomically, it consists of a *bony* and *membranous labyrinth.*

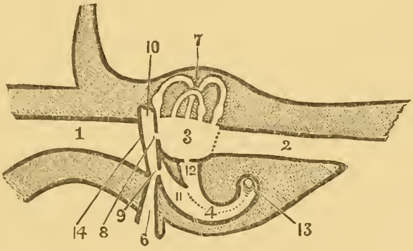

Fig. 25.

The bony labyrinth (see Fig. 25) is composed of three parts or divisions: the vestibule, the cochlea, and the semicircular canals. These structures are all hollow, and their cavities communicate with each other.

Fig. 25.—Bony labyrinth. 1. External meatus; 2. Internal meatus; 3. Vestibule; 4. Cochlea; 6. Eustachian tube; 7. Semicircular canals; 8. Fenestra ovalis; 9. Fenestra rotunda; 10. Tympanum; 11. Scala tympani; 12. Scala vestibuli, communicating with the vestibule; 13. Helicotrema; 14. Membrana tympani.

The vestibule is a small irregular cavity, just internal to the tympanum, central in position, and seems to be the cavity of communication for the other parts of the labyrinth. Its external wall is perforated by the fenestra ovalis, by means of which communication is established between the tympanum and the bony labyrinth. It will be remembered that this fenestra, in health, is closed by the foot of the stapes and its annular ligament. The anterior wall contains a large round foramen, which opens into the cochlea. In the posterior-upper walls are five foramina leading into the extremities of the three semicircular canals, two of them having one common opening into the vestibule. The anterior inferior portion of the internal wall is perforated by numerous small holes for the transmission of the filaments of the auditory nerve, giving the bone a sieve-like appearance, and hence it is said to be *cribriform.*

The cochlea is so named from its resmblance to a snail shell, and is situated in front of the vestibule, forming the anterior part of the labyrinth. It is conical in shape, and is made up of a conical tube wound two and a half times around a central axis (modiolus), which is also conical. The base of the modiolus is directed inward against the bottom of the internal auditory meatus, and is perforated by numerous foramina for the transmission of the cochlear portion of the auditory nerve. Its apex is directed outward and forward, is funnel-shaped, and is therefore called infundibulum. The foramina of the base extend through the length of the modiolus toward its apex in the form of little canals, through which the auditory nerve filaments pass to the tubular portion of the cochlea. In the last half round the conical tube terminates somewhat abruptly in a rounded extremity—the cupola—which is the apex of the cochlea. The calibre of this tube is divided into two canals, called scalæ, by a septum, running from the base to the apex of the cochlea, which is technically called *lamina spiralis.* Only a portion of this septum is bony; the bony part being continued by a delicate membrane across the calibre of the tube. To the membranous portion of the lamina spiralis the cochlear portion of the auditory nerve is distributed, the nerve canals passing in between the layers of the bony portion. The extreme end of the lamina spiralis is known as the *hamular process.* The septum is complete, except at the apex of the cochlea, where there is a small opening, through which the two portions communicate, which is called *helicotrema.* As already stated, the septum divides the tube into two scalæ or canals. One of these communicates with the vestibule through the large round opening in its anterior wall, already mentioned, and is therefore called *scala vestibuli;* the other communicates with the tympanum through the fenestra rotunda, closed in the recent state by the membrana tympani secundaria, and is therefore called *scala tympani.*

In the membranous part of the lamina spiralis is situated the very complicated structure known as the organ of *Corti*, who discovered it. *Helmholtz* speaks of it as a musical instrument and calls it, somewhat enthusiastically, "a lute of three thousand strings, receiving the music of the outer world, and rendering it fit for reception by the brain." It is supposed, therefore, that this organ, located in the septum of the cochlea, distinguishes the different musical tones. There is another theory that the human voice is controlled or governed by the cochlea.

The *semicircular canals* are three in number, and, although they are called *semi*-circular, they form near two-thirds of a circle. They bear an interesting relation to each other; no two are parallel, but the plane of each is about perpendicular to the other two. They are named, according to position, the *superior*, *posterior*, and *horizontal*. One extremity of each canal has a sudden enlargement called *ampulla*, otherwise they are uniform canals.

The semicircular canals lie above and behind the vestibule, into which they all open by five foramina, as already stated, two extremities having one common foramen.

The function of these canals, at least in part, is supposed to be the regulation of movements. This, however, is still theoretical—unsettled.

It will be observed from the foregoing very short description, that all the different parts of the bony labyrinth communicate directly with each other and with the cavity of the tympanum, the latter being separated from the former only by intervening membranes. This fact shows that a single vibration is sufficient to excite the whole auditory nerve, although it is distributed to different parts of the labyrinth.

The whole interior of the bony labyrinth is lined by a kind of compound membrane: one side is periosteum; while the other side is a serous membrane, at least a kind of serous fluid is secreted from its surface, which fills the entire cavity of the bony labyrinth. This fluid is called *aqua labyrinthi* or *perilymph*, which some suppose to be identical with the cerebro-spinal fluid.

THE MEMBRANOUS LABYRINTH (see Fig. 26) corresponds very closely to the bony labyrinth, except there is no membranous cochlea. The membranous labyrinth floats, as it were, in the perilymph of the bony labyrinth. The only attachment between the two is where the nerves and blood vessels pass across from one to the other. The membranous labyrinth being contained within the bony labyrinth, its parts are considerably smaller than the corresponding portions in the bony labyrinth.

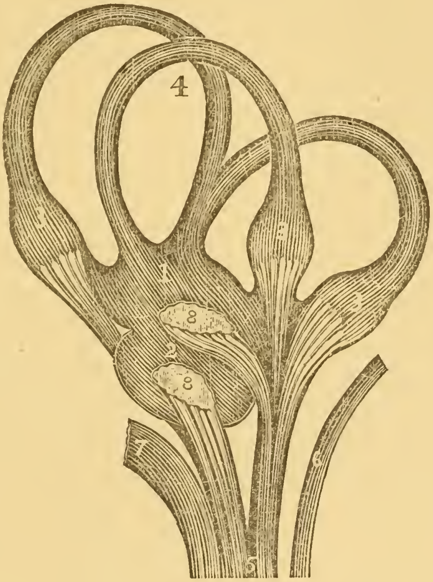

Fig. 26.

The vestibule of the membranous labyrinth is composed of two small sacks, the utricle and saccule.

The *utricle* (see Fig. 26) is the larger of the two, has an irregular oblong shape, and lies in contact with the posterior upper portion of the inner wall of the bony vestibule. In its upper and posterior aspect are five

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Fig. 26.—Membranous labyrinth. 1. Utricle; 2. Saccule; 3, 3, 3. Ampullæ; 4. Semicircular canals; 5. Auditory nerve; 6. Facial nerve; 7. Cochlear part of auditory nerve; 8, 8. Otoliths (otoconia), situated inside. Portions of the nerve go to the ampullæ and portions to the utricle and saccule.

orifices, corresponding to the five openings of the membranous semicircular canals.

The *saccule* (see Fig. 26) is smaller and somewhat elliptical in form, and lies against the anterior lower portion of the inner wall of the vestibule, near the foramen leading into the scala vestibuli. There is no known communication between the cavities of the saccule and utricle. More recent investigators (*Reissner* and *Reichert*) think that the saccule is the vestibular end of the membranous portion of the lamina spiralis, which, according to these writers, is not simply a membranous septum, but is rather a canal or duct; hence they call the membranous part of the lamina spiralis *ductus cochlearis*. The theory, then, of these authorities is that the saccule forms one end of that duct, and more properly belongs to the cochlea.

The *membranous semicircular canals* (see Fig. 26) correspond in form exactly to that of the bony semicircular canals, in which they are contained. Their diameter is about one-third that of the bony canals. As already stated, the membranous canals communicate with the utricle by five orifices, one being common to two. The membranous labyrinth is filled with a serous fluid, supposed to be secreted by its inner surface, and is called *endolymph*.

The *auditory nerve* enters the labyrinth from the bottom of the internal meatus through numerous small foramina, and is distributed to different parts of the membranous labyrinth and to the cochlea. Before the nerve enters the bone, it breaks up into several bundles, which are named according to the points of distribution.

The manner of distribution is well shown by the accompanying cut (Fig. 26). From this it will be observed that a large portion of the nerve goes to the cochlea, while smaller portions go to the utricle, saccule, and the ampulla of each canal. It is a singular fact that the distribution of the nerve is limited to such small portions of the membranous labyrinth. On the inner surface of the utricle and saccule, corresponding to the points of distribution of the nerve, is to be seen a small collection of a white substance, which, upon closer examination, is found to consist of a large number of fine crystals of carbonate of lime, held together and in position in some unknown way. Some think they are contained in a delicate cyst; others think they are imbedded in a kind of delicate connective tissue. It is *supposed* that these crystals have something to do with the final termination of the nerve filaments.

Blood Vessels.—The labyrinth gets its blood supply from the cavity of the cranium through the arteria auditiva interna, a branch of the basilar artery.

At the bottom of the meatus the artery divides into two branches, the *cochlear* and *vestibular*. The former enters and supplies the cochlea; the latter supplies the vestibule and semicircular canals.

The venous blood is returned to the cranial cavity and empties mostly into the superior petrosal sinus.

The meninges of the brain accompany and inclose the auditory nerve down to the bottom of the meatus auditorius internus, making, in addition to the vascular connection, an intimate relation between the brain and the labyrinth.

Diseases of Labyrinth are, no doubt, quite common, but, in the present state of aural science, it is impossible to diagnose many of them with any degree of certainty. The only way to approach a correct diagnosis is by a process of exclusion. A man is deaf and wants to know the cause of the deafness. Upon examination, all the visible parts of the ear are in a perfectly healthy condition. The cause of deafness, therefore, is not a disease of the external meatus nor of the membrana tympani. Further inspection shows that the throat is healthy—the tonsils not enlarged. Disease of the throat, therefore, is excluded from the possible causes. The condition of the Eustachian tube and drum must be determined by inflation and auscultation. If these prove to be healthy, and the history of the case does not indicate that a previous inflammation has existed in the drum or tube, then these are to be likewise excluded. The cause of the deafness, therefore, must be a disease of the labyrinth, as everything else has been excluded.

In this way a correct diagnosis can be *approached*—I do not say it can be definitely settled.

In order to determine the nature of the labyrinth disease as far as possible, a close consideration of the history of the rise and progress of the trouble is very necessary. Did the deafness come on suddenly or gradually? Did the man get a blow on the head? Did he fall? Was he exposed to violent concussions of the air from explosions of any kind, as in artillery practice? Did he have apoplectic symptoms? Has he had any disease of the brain? Is there any facial paralysis? Such questions will usually give the physician an insight into the character of the disease, and enable him to make out a probably correct diagnosis, although there is, at best, considerable uncertainty in all diseases of the labyrinth.

NERVOUS DEAFNESS, properly speaking, is caused by a disease of any kind that involves the ultimate distribution of the auditory nerve. Hence only diseases of the labyrinth, whether primary or secondary, can cause nervous deafness, as the whole auditory nerve is distributed in that part of the ear. The deep-seated and remarkably well-protected position of the labyrinth would naturally preclude the probability of its being frequently involved in disease, and, as a result, a correspondingly infrequent occurrence of nervous deafness would be expected.

Clinical observation sustains this natural inference, and shows that genuine nervous deafness is of rare occurrence. A rigid *diagnosis by exclusion* reduces the number of cases to a minimum which is surprisingly small; according to *Kramer*, of Berlin, about four in a thousand.

Formerly, *nervous deafness* covered, to a large extent, the pages of every note-book; now it is a rarity. This fact shows clearly the rapid progress otology has made in the last few years. There is no doubt but that further progress will simplify and reduce the number of cases still more.

An exactly parallel illustration may be taken from ophthalmology. Only a few years ago, *amaurosis* was of more frequent occurrence, if anything, than nervous deafness; but the recent progress of that science has almost obliterated the word from the catalogue of ophthalmic diseases.

The Causes of nervous deafness, in general terms, are: Fractures through the labyrinth, falls, blows on the head; violent concussions of any kind, as blasting, artillery, or a sudden clap of thunder (I have just examined an old German woman, who attributes her deafness to a flash of lightning passing close to her head nine years ago. The deafness and fearful tinnitus aurium came on immediately, and have persisted ever since); a discharge of fire-arms of any kind, or any kind of explosions. All these are *traumatic* causes. There is another class of causes, which may be regarded as *spontaneous*, such as primary and secondary inflammation in the labyrinth. As exciting causes of this inflammation, may be mentioned the acute exanthemata and other eruptive diseases, continued fevers, erysipelas, syphilis, and so on.

THE PATHOLOGICAL CHANGES in the labyrinth vary according to the exciting cause and severity of the labyrinth disease.

THE PROGNOSIS is unfavorable in all cases of nervous deafness. Very few are benefited in the least by any known treatment. When a case is benefited, there is reason to suppose that a mistaken diagnosis was made in the beginning.

TREATMENT.—As nervous deafness is beyond the reach of the physician, there is very little encouragement for treatment; still the usual routine of blisters, leeches, vesicants, alteratives, nervines, electricity, change of climate, change of business, water-cures, etc., may be tried, as a satisfaction to a solicitous and anxious patient. I have never seen any good results follow such treatment.

INFLAMMATORY AFFECTIONS OF THE LABYRINTH (otitis interna).—*Prof. Knapp*, of New York, has written, recently, a very elaborate and interesting article on this subject (see Archives of Ophthalmology and Otology, vol. 2, No. 1), in which he reviews the literature of labyrinthine inflammation down to a late date. I give his general summary at the close, which embodies, in a concise form, the most recent ideas of the profession on this difficult subject:

"When *deafness occurs almost suddenly, under apoplecti-*

form symptoms, in a previously healthy person, and the apoplectiform symptoms disappear rapidly and completely, but the deafness remains, then the seat of the disease is in the cavity of the labyrinth, and its pathology probably hemorrhagic or serous effusion.

"The deafness resulting from *injuries* on the head is caused by fissures or fractures of the petrous pyramid, with consequent hemorrhage and inflammation in the membranous labyrinth, or, perhaps, by isolated rupture and hemorrhage in the soft parts of the labyrinth, by 'contrecoup.'

"The chain of symptoms known as *Ménière's disease*, viz., deafness and tinnitus aurium, occurring under symptoms of apoplectiform cerebral congestion, may be a *primary* or a *secondary* affection of the labyrinth.

"The former is to be assumed when, in a previously healthy person, the symptoms on the part of the labyrinth—tinnitus, contraction of the range of audition, and hardness of hearing—are prominent and persistent; while the general symptoms—headache, paleness of the face, fainting, obscuration of the visual field, vertigo, nausea, vomiting, and disturbances of equilibrium—can not be referred to actual disease of the brain or the constitution, and are transitory. The pathology of *Ménière's* disease is most likely hemorrhagic and serous inflammation within the whole labyrinthine cavity. *Increase of intra-auricular pressure* may be considered a primary consequence of it, upon which other symptoms—vertigo, nausea, vomiting, disturbance of equilibrium, etc.—depend. Glaucoma of the eye is, perhaps, a counterpart to Ménière's disease.

"Ménière erred in confining the disease to the *semicircular canals*, the accompanying deafness being evidence that the cochlea is involved. That the disease is neither an affection of the trunks of the auditory nerves, nor of their centre in the brain, is demonstrated by deafness for high and low tones—a contraction of the range of audition—as I have witnessed. This symptom can be explained only by changes in those parts of the cochlea which are subservient to the perception of high and low tones. It is analogous to the contraction of the visual field in glaucoma.

" Ménière's disease may be *secondary* to affections of the *tympanum*, the *brain*, and the *general system*. I have reported typical cases in proof of this assertion.

" In chronic *aural catarrh*, the whole chain of the symptoms of Ménière's disease may occur as an acute complication—caused by exposure—disappear, and leave the chronic catarrh in its previous condition, but with increased deafness and tinnitus. In such cases, the inflammatory symptoms of the labyrinth may be well marked without noticeable aggravation of the otitis media.

" The deafness, mostly total, occurring in the course of acute *meningitis* and sporadic or epidemic *cerebro-spinal meningitis*, is due to *purulent otitis interna*, a complication—perhaps a metastasis—of the purulent inflammation of the meninges, in the same way as purulent choroiditis, is not an infrequent complication of the same diseases. Voltolini's opinion, that the whole affection in such cases is an inflammation of the labyrinth alone—otitis labyrinthica, mistaken for meningitis—lacks both foundation on pathological anatomy and clinical analogy.

" Among the *general diseases* which are liable to produce deafness, *constitutional syphilis* furnished a valuable example in a case, showing a pure attack of Ménière's disease, in a patient who soon after had an analogous affection of his eyes. This being exudative irido-choroiditis, chiefly of a serous character, it may be inferred that the labyrinthine affection also was a serous exudative inflammation. *Severe fevers*—for instance, *typhus* or *typhoid; acute exanthemata; variola*, *scarlatina*, *rubeola; eclampsia infantum; erysipelas; pustular* and *eczematous eruptions on the head; mumps*, *angina Ludwigii*, and *sunstroke*—are all apt to produce deafness without material changes in the middle ear. The most probable anatomical lesion in all these seems to be serous or hemorrhagic inflammation in the labyrinth.

"The lesion producing deafness after childbirth may be of the same nature or metastatic, as in severe puerperal fevers; anæmia, in certain cases.

"We may therefore subdivide *otitis interna into three kinds:*

"1. *Hemorrhagic:* sudden and traumatic deafness.

"2. *Serous exudative*, or *simple:* idiopathic Ménière's disease, and the deafness from syphilis, severe fevers, acute exanthemata, erysipelas, and other constitutional diseases.

"3. *Purulent:* a *primary* disease of traumatic origin, perhaps also spontaneous and sui generis (Voltolini), and *secondary* in simple and cerebro-spinal meningitis, puerperal fever, and other pyæmic diseases.

"The *diagnosis* of inflammation of the labyrinth is mainly supported by the symptoms of permanent irritation and paralysis of the auditory nerve—tinnitus aurium and deafness, accompanied by transitory cerebral symptoms—headache, paleness of the face, vertigo, fainting, nausea, vomiting, disturbance of equilibrium, without marked changes in the middle or outer ear. Secondary inflammation of the labyrinth is to be assumed, when, in the general diseases enumerated above, tinnitus aurium and deafness, without symptoms of otitis media, are well marked.

"The *prognosis* of idiopathic otitis interna varies with the nature and cause of the inflammation. In traumatic cases, the hearing may be partially or almost totally restored. The secondary affections of the labyrinth in typhoid fever, syphilis, and other constitutional diseases, may terminate favorably, or, on the other hand, leave all possible degrees of hardness of hearing, even total deafness being not infrequent. Idiopathic serous exudative otitis interna, if we may call Ménière's disease by that name, is mostly fatal to the hearing. If the first attack be not severe, and do not destroy the hearing more or loss completely, other attacks will follow, at indefinite intervals, and gradually result in deafness. The course of this disease bears great analogy to glaucoma. Purulent otitis interna is almost always followed by complete deafness. Only in exceptional cases of cerebro-spinal meningitis hearing has been restored.

"The *treatment* of labyrinthine affections is still more in its infancy than is its pathology. Antiphlogosis and derivation, both locally and constitutionally, with due regard to the nature of the general symptoms, are indicated in all recent cases. Leeches behind the ears; aperient remedies, among which calomel may be preferred; sudorifics, digitalis, etc., and absorbents; hydrargyrum, iodide of potassium, etc.; afterward, vesicants over the mastoid region should be recommended. Electricity, according to different methods, has nearly always failed; Brenner's method, however, claiming success in exceptional cases, may be tried. I have employed it in nearly all the recorded cases, but without a shade of improvement. If the increase of intra-auricular tension were better known as a fundamental and detrimental symptom, in certain inflammations of the inner ear, we should endeavor to get access to the cavity of the labyrinth with proper instruments, perhaps best by one of the fenestræ, in order to evacuate a part of the perilymph."

MENIERE'S DISEASE.—Sudden tinnitus aurium and deafness more or less complete, occurring in an otherwise healthy person, together with severe cerebral symptoms, such as headache, pallor, fainting, nausea, vomiting, defective vision, and unsteady walk (disturbances of equilibrium), constitute what is known as *Ménière's disease*; so called because *Ménière* first described the disease minutely some years ago, and reported at the same time several cases. In one of these cases a post-mortem was made. The brain and its membranes were healthy, but acute inflammation was discovered in and confined to the semicircular canals. Besides this, physiological experiments on birds and animals seemed to show that injuries of the semicircular canals would produce similar symptoms in them. Hence, *Ménière* concluded that the disease was confined to the semicircular canals. But later investigation has disproven his inference and shown that the above symptoms indicate a disease of the entire labyrinth. According to *Knapp*, it is often secondary to other diseases, as stated in the above extract.

The general result of the disease is about this: the deafness and tinnitus aurium continue; the cerebral symptoms gradually subside, and leave the patient in good general health. This is pathognomonic of labyrinthine disease. Did the severe cerebral symptoms depend upon disease of the brain they would be more permanent. They are probably due to *intra-auricular* pressure (Knapp) and persist only while that lasts. *Troeltsch* has shown that the same train of symptoms may be excited by pressure upon the membrana tympani, as by plug of wax, which is indirect pressure upon the labyrinth. It has already appeared that acute inflammation of the tympanum sometimes simulates brain disease very closely, most probably on account of pressure upon the labyrinth.

Ménière found that treatment availed but very little. If anything is done, the general course of treatment already referred to may be tried.

Deafness from Cerebro-spinal Meningitis.—As is well known, total deafness often accompanies or follows an attack of this disease. The few post-mortem examinations that have been made, show that the cause of the deafness is purulent inflammation of the labyrinth, most probably of a secondary character, the acute meningitis extending along the auditory nerve to the labyrinth. *Knapp* suggests that *metastasis* may occur, which amounts to about the same thing.

Some writers have suggested that the deafness may be caused by involvement of the auditory nerve either in its origin or course. This is plausible enough; but the fact that facial paralysis is so rarely observed in connection with cerebro-spinal meningitis, would seem to disprove the theory, as that nerve would necessarily be involved along with the auditory nerve.

Voltolini has affirmed that cerebro-spinal meningitis is acute inflammation of the labyrinth. Were that true, then all the cases should become and remain deaf, which is by no means the case.

The *prognosis* is very unfavorable. I have never seen a case improve even the slightest, where there was total deafness.

Treatment is more than useless in cases of absolute deafness. I have long since ceased to treat such cases. Years ago I tested all kinds of treatment thoroughly, but found it useless. If there is only partial deafness, then treatment may do some good.

Cerebral Deafness.—All cases of deafness, whose cause is a disease of the brain or its membranes, which has not extended to the labyrinth, belong to this class. The chief diseases of the brain that may cause cerebral deafness, are injuries of the head, causing hemorrhage about the base of the brain and pressure upon the trunks of the auditory nerves; so also spontaneous hemorrhage, as in apoplexy. Tumors of the brain may cause pressure upon the course of the nerves and consequent deafness. Deafness may follow softening of the brain when the origins of the auditory nerves are involved.

The swelling and effusion in simple meningitis (in contradistinction to cerebro-spinal meningitis, which usually involves the labyrinth, as already stated) or cerebritis may cause this form of deafness, by pressure upon the nerve trunks.

In all these cases of cerebral deafness, other grave cerebral symptoms are nearly always present, which assist materially in making out a diagnosis.

Partial or complete facial paralysis would naturally be expected where there was pressure upon the trunks of auditory nerves. Partial or total paralysis of other parts of the body would be likewise expected, according to the extent and locality of the brain disease. Tumors in the brain usually cause intense and increasing suffering. To all of these may be added vertigo, nausea, vomiting, spasms, stupor, etc. These not only persist, but increase, till death terminates the scene.

Treatment.—This must be directed, not to the deafness, which is only a symptom, but to the original disease of the brain. The treatment, of course, will vary according to the nature of that disease. Most of these cases are incurable, and consequently a great deal can not be expected from treatment. The traumatic and inflammatory cases may be benefited by antiphlogistic and absorbent remedies.

Double Hearing (paracusis duplicata) is a rare affection comparatively, although numerous cases have been reported by writers. The double sounds have been observed mostly with respect to tones or music, but ordinary sounds may also be heard double. It is not difficult to understand how a person might hear double with *two* ears, but how it is possible for him to hear double with a *single* ear is somewhat remarkable. Still such cases are reported by undoubted authorities.

The descriptions of double hearing, as given by patients, are about as follows: When a musical note is struck, the normal ear (supposing that one is healthy) receives the natural tone, while the diseased ear receives a higher or lower tone; that is, the patient gets two musical sounds from one musical note. If a single ear hears double, one note is normal and the other is higher or lower, usually higher. This would seem to indicate that a part of the ear is healthy and a part is diseased.

I have already stated that *Helmholtz* thinks that the musical part of the ear is located in the cochlea, and that the so-called organs or fibres of *Corti* constitute the musical instrument. To explain, then, the double tone, it is only necessary to suppose that a part of this instrument is disarranged, is diseased (out of tune); hence the two musical sounds. This is the explanation usually given of the phenomenon of paracusis duplicata. Whether it is correct or not, I am unable to say.

The reports of some cases, where there was no evidence of any disease of the labyrinth, in fact every reason to believe that it was entirely free, throw considerable doubt upon the correctness of the above explanation.

Moos, to whose clinical report on otology I am largely indebted for the above details, mentions the case of a tenor singer, who was suddenly attacked with double tones, which annoyed him so much he could not continue to sing. Upon examination, a simple catarrh of the tympana was discovered, with considerable deafness on both sides. A few inflations were followed by perfect relief. It is hardly possible that there could have been any disease of the labyrinth in that instance.

The same writer mentions, as the causes of double hearing, tympanic diseases, severe concussions of the labyrinth, blow on the ear, or general nervous disease.

TREATMENT must be directed against any active disease that may be found in the ear, as that may be the exciting cause of the double hearing.

TONE DEAFNESS.—This is very closely allied to paracusis duplicata. Some persons can hear one tone better than another—a high tone, for instance, better than a low one. Some tones they can not hear at all. Hence it is called *tone deafness.* Such patients can hear persons with soft voices talk much better than persons with coarse voices, or *vice versa.* Tone deafness has a strong analogy to color blindness, which is not an uncommon affection of the eyes, and is supposed to indicate a disease of the optic nerve.

The same explanation has been given in tone deafness as in double hearing, that it is a disarrangement, in some way, of the organs of *Corti.* The fact is, the whole matter is very obscure.

TINNITUS AURIUM.—It will be remembered that noises in the ear, of various kinds and degrees, have been a constant symptom of nearly all the diseases of all parts of the ear that have been considered in the foregoing pages. These noises are the result of any kind of irritation of the auditory nerve, as *Troeltsch* observes, either in its ultimate distribution in the labyrinth or in its course from the brain. Any increase or decrease of pressure upon the fluid of the labyrinth, as when the stapes is pressed inward or drawn outward, causes noises in the ear, which vary according to the degree of pressure or traction. The pressure follows upon every obstruction of the Eustachian tube that is sufficient to interrupt or interfere with the ventilation of the tympanum. Traction upon the stapes is produced by every collection of fluid in and consequent distention of the tympanic cavity, or by air-tight closure, from any cause, of the external meatus. It is impossible to tell from the nature of the noises what the exciting cause is or where it is located. It may be in the external meatus, or it may be in the cranial cavity.

A very ugly, and perhaps the most persistent form of tinnitus aurium, accompanies the various stages of aural catarrh.

Pulsating noises in the ear accompany all forms of physical obstruction to the arterial circulation in the ear. The correctness of this statement is shown by the frequent production of pulsations by pressure upon the ear. These pulsating noises can often be detected by auscultation, particularly if they are very loud, as in the development of an aneurism or tumors of other kinds in or about the ear.

Cracking noises in the ear are produced by a collection of mucus in the tympanum, as in the moist stage of aural catarrh. Air passing through the mucus causes the cracking sounds, which patients often describe as *air-bubbles.* Some persons can produce, voluntarily, a cracking noise in the ear, which *Politzer* says is caused by a separation of the membranous from the cartilaginous portion of the tube by the contraction of the tubular muscles.

Troeltsch and *Politzer* speak of noises produced by contraction or spasm of the tensor tympani muscle. This belongs, however, more properly to tinnitus from pressure upon the labyrinth.

Troeltsch describes also a tinnitus as due to the peculiar condition of the blood, as in anæmia and chlorosis. This form of tinnitus is very similar to the venous blowing in some chlorotic females.

Intra-labyrinthine diseases of all kinds produce tinnitus aurium of the severest character. Blows on the head, injuring the brain and possibly the labyrinth, are often productive of singing in the ears.

Violent concussions, as from explosions of any kind, are often followed by subjective noises. Only a few days ago I examined an old woman (already referred to under Nervous Deafness), who stated that nine years ago a flash of lightning passed very close by her head. Fearful noises, which she described as dancing, jumping, yelling, singing, music, etc., set in at once in one of her ears and has persisted ever since. They are so loud and distressing she gets but very little rest, and often says it seems to her like other people ought to hear them.

There are other noises in the ears where no cause whatever can be discovered. Such noises may be properly called *nervous,* most likely depending upon some unknown functional disturbance of the auditory nerve.

Cases have been reported of tinnitus aurium from reflex irritation of the auditory nerve, the result of peripheral irritation of some of the nerves of sensation.

The character of the noises in tinnitus aurium is as varied as external sounds, according to the description of patients. In a few words, they range from the slightest unnoticed blowing or singing to a regular *storm* of noises, as a combination of hammers, bells, steamboats, railroad cars, machine-shops, singing, instrumental music, and so on. These noises are always, I may say, very annoying and sometimes fearfully distressing, producing even mental disturbances, and sometimes even loss of mind.

Troeltsch and *Roosa* refer to a case or two where the patients said the tinnitus was delightful music to them. Such cases, however, are the rarest exception.

TREATMENT.—The cause of the tinnitus must be sought out and removed as far as possible. If there is aural catarrh, that must be treated. I have already said that this is the most frequent cause of tinnitus. In all such cases inflation is to be mainly relied upon, as that is the best means of relieving pressure upon the labyrinth and removing whatever collections there may be in the tympanum. If there is any inflammatory affection in any part of the ear, throat, or nose, that must be treated. If enlarged tonsils are present, they should be removed (amputated). If there is good reason to believe that contraction or spasm of the tensor tympani is the cause of the noises, then tenotomy of that muscle is indicated. If there is a plug of wax or foreign body in the meatus, that should be removed. If the noises are produced by intra-cranial or intra-labyrinthine disease, that must be treated, if the prospect is sufficiently encouraging to institute treatment. If, finally, the tinnitus aurium is *functional* or *nervous;* if, in other words, it has no visible cause, then the various nervines, including anodynes and electricity, may be *tried*, with the understanding that there is very little prospect of benefit.

In general, a large per cent. of the cases of tinnitus aurium will be found to be absolutely incurable in the present state of otological science. Many such cases would much prefer absolute deafness to the distressing noises that torment them day and night for a lifetime.

In such cases, were it possible with safety to obliterate all perception of sound, it would prove a boon to the unfortunate sufferers. Some of them go crazy, while others, when they find that there is no hope, seek final relief in self-destruction.

May it not be hoped that before long some new and effectual treatment for tinnitus aurium will be discovered!

ELECTRICITY IN AURAL AFFECTIONS.—It is not yet definitely settled whether electricity is beneficial in the treatment of diseases of the ear or not. I have never been able to see any good effect from it in any form of aural disease. *Gruber* doubts its efficacy. *Knapp* has never seen any good result from it. *Troeltsch* is undecided in regard to the matter. On the contrary, *Brenner* and *Hagen* claim to have had most remarkable results from its use in nearly all forms of aural disease. *Neftel* confirms all that *Brenner* has said, after repeating his experiments. Others, again, deny *Brenner's* statement in toto.

So, altogether, it is safe to say that the efficacy of electricity in the treatment of diseases of the ear is still unsettled—is still in doubt.

Troeltsch remarks that he is disposed to look with suspicion upon any remedy that seems to be so universally applicable as electricity in the hands of *Brenner* and others. This fact certainly shows that they are enthusiastic in its praises, if they do not even make a hobby of it. Then, again, electricity is not often used alone, so that it is difficult to say what benefit is derived from it, and what is due to other means of treatment used at the same time.

The following is *Brenner's* method of applying electricity to the ear: An insulated wire, which has free extremities, is passed through the catheter some distance into the tube. The head is inclined to the opposite side, and the external meatus is partly filled with water (warm is best). Now the zinc pole (negative) is immersed in the water, while the copper pole (positive) is brought into contact with the outer end of the above wire, which closes the circuit, and electrization of the tympanum and adjacent parts begins. The battery should never be strong enough to cause great shock or severe pain. The length of time it should be continued at each sitting must be left to the judgment of the physician.

Brenner and his followers insist upon the necessity of following these directions *literally*, in order to get the benefit of electrical treatment.

The use of electricity in aural diseases should not be given up, but its trial should be continued, in the hope that it will finally prove beneficial, and the whole matter be reduced to something positive.

Preference is usually given to the galvanic current for therapeutic purposes.

Brenner and his followers claim that electricity is a valuable means of diagnosis, to determine whether the auditory nerve is diseased or not. If a current of electricity is passed through the ear, as just described, a "strong sensation of sound" is produced, if the auditory nerve is healthy. If this sound is not produced, then the nerve is diseased.

Other authorities deny this statement, particularly with respect to the effect of electricity upon a healthy ear; consequently, they say, no definite conclusion can be reached in this way.

This is another evidence of the unsettled condition of electrical therapeutics.

Otalgia (pain in the ear) comprises two classes of earache: 1. *Inflammatory otalgia*; 2. *Neuralgic otalgia.*

Inflammation of any part of the ear may, and usually does, cause severe pain, as the preceding pages abundantly prove. But otalgia (common earache) does not refer to the pain caused by the graver forms of aural inflammation, but rather to the milder forms, which often cause periodic earache, with which young people are particularly liable to be troubled. Every mother of several children can tell how often some one, or all of them, has cried all night with earache. Attacks of otalgia, from inflammatory causes, usually come on at night. A reason for this will appear when it is remembered that aural inflammation is always more painful at night than in daytime. During the day, the child does not notice the ear trouble, but the paroxysm at night prevents sleep and causes it to cry. Upon inspection, the membrane shows, as a rule, an unnatural red appearance, most likely caused by a congestion or inflammation of the mucous membrane of the tympanum.

Neuralgic otalgia attacks all about alike; if anything, grown people are more subject to it than young. The nature and cause of aural neuralgia, like neuralgia in general, are somewhat obscure. The seat of the neuralgia is to be found, no doubt, in the aural branches of the trifacial nerve.

Neuralgic otalgia not unfrequently results from reflex irritation, as from a carious tooth. Several cases of the kind have been reported. Some years ago, my wife nad a severe otalgia in one of her ears. She discovered that one of her molar teeth was tender upon pressure, and had it extracted. The earache disappeared immediately. In fact, it is sometimes difficult for a patient to tell whether the pain is in the ear or teeth—whether he suffers from toothache or earache.

Treatment.—I am in the habit of using a solution of atropine (from 1 to 4 grs. to ounce of water) for otalgia, whether inflammatory or neuralgic. This is to be dropped into the ear (3 to 6 drops at a time) as often as necessary, on account of the pain. One application is often sufficient. I have reason to be well pleased with the results of this treatment. It is not only palliative, but is, in some way, curative. The solution should be allowed to stand in the ear a few minutes. It should be used with care in small children, as they are unusually very susceptible to the effects of the atropine. I have never seen any unpleasant symptoms from it.

Next to atropine, I would advise the use of a solution of morphine (2 to 6 grs. to ounce). That is less irritating and more soothing than laudanum. Diluted chloroform may be used on cotton, but that is too irritating.

If there is any reason to think that the otalgia depends upon the irritation of a carious tooth, that, of course, must be either removed or filled. Its removal will most probably be necessary, although *Troeltsch* reports a case in which filling stopped the earache.

AURAL DISEASE BLUNTS THE MENTAL POWERS.—That a healthy condition of the ear is essential to vigorous mental labor is proven by many observations. Particularly does aural catarrh hinder continued and profound application of the mind. *Troeltsch* first directed attention to the fact that aural catarrh not only interferes with mental labor, but renders patients sometimes excessively nervous and irritable. It is not uncommon to hear a patient with aural catarrh say: "I can not think any more as I used to; the smallest mental labor debilitates me almost to prostration; my memory is defective; my mind is not clear; something must be wrong with my brain, I feel so depressed and stupid." Such are about the remarks patients often make, particularly when they have constant distressing tinnitus aurium. I have already stated that noises in the ears sometimes distract patients so that they either go crazy or commit suicide. I remember a little boy, about twelve years old, who frequently became so enraged over the noises in his ears that he would maul his head with his fist with all the strength he could command, and would even strike it against the wall.

I have repeatedly, in these pages, called attention to the brain symptoms produced by local diseases of the ear, and particularly so when those diseases were located in the drum. A distressing feeling of fullness and heaviness about the ears, it will be remembered, is one of the prominent symptoms of aural catarrh, causing, sometimes, vertigo, nausea, and even vomiting. This fullness is, no doubt, caused by pressure upon the labyrinth and through it, indirectly, upon the brain. Hence the brain symptoms. *Troeltsch* thinks that some of these symptoms may be caused by impressions upon the tympanic plexus, particularly the sympathetic filaments of that plexus.

This pressure upon the labyrinth and indirect pressure upon the brain (all the result of unequal atmospheric pressure upon the drum, in consequence of imperfect ventilation of that cavity) is certainly the cause of the depressing and blunting effect of aural catarrh on the minds and spirits of patients. Exactly the same results may follow exudation in the labyrinth in sufficient quantity to cause the same amount of pressure.

In favorable cases of this kind, it is very interesting to observe the remarkable change that comes over the sad countenances of patients when the heaviness is lifted, as it were, from their minds and spirits by the simple act of inflation.

Unfortunately, however, only some of the cases are thus easily and completely relieved. In those cases where inflation has no favorable impression, it is to be supposed that the cause of the trouble is in the labyrinth, beyond the reach of this or any other treatment.

Loss of Voice in the Deaf.—Young people, who lose their hearing, become dumb, as a rule. When they cease to hear sounds, they forget language very soon, and consequently cease to make any effort to talk. They do not actually lose their voices, but cease to use them. Teachers of the dumb now claim to be able to prevent young people (children) from becoming dumb, by a course of systematic and careful training.

Grown people do not often cease to speak entirely when they become deaf, but their voices undergo very considerable change. They, not being able to hear themselves speak, are not able to regulate or modulate their voices. Hence it is not uncommon to hear a deaf man speak in a soft, gentle, and scarcely audible whisper, or he may raise his voice almost to a yell, thinking that he is speaking in an ordinary tone. For this reason, public speakers, when they become deaf, usually have to give up their profession, at least so far as public speaking is concerned. A prominent minister in Indiana became deaf, but continued to preach. In a short time he began to raise his voice to such a high pitch that it became extremely unpleasant to his hearers, or he would lower it to a mere whisper, so he could not be heard at all. If, under such circumstances, a person is informed of the fact, his effort to correct the matter is very apt to make it worse.

These changes of the voice in grown people, when they become deaf, can not be prevented. To see the voice begin to change in cases of hardness of hearing is always an unfavorable indication.

EAR-TRUMPETS.—When a person becomes so deaf that he can not enjoy intercourse with his friends, or can not listen to a public lecture or sermon with any satisfaction, then he should use an ear-trumpet, which is an artificial means of assisting the hearing by concentrating or increasing the force of sonorous vibrations. The instrument is called ear-trumpet because it is trumpet-shaped; that is, it is big or funnel-shaped at one end, and small or pointed at the other. The little end is placed in the external meatus, and the large end collects and concentrates the sonorous vibrations of the air upon the membrana tympani. In this way the force of sound is increased and the hearing assisted.

The variety of ear-trumpets is almost infinite, but the principle of all is the same.

When a person wants an ear-trumpet, it is well to let him try the different varieties, and select for himself whatever one suits him best. He can judge for himself better than the physician can.

Troeltsch observes that he has seen persons prefer and use an ox's horn in preference to any other form of ear-trumpet.

The great objection to the use of ear-trumpets is that they necessarily show a person's infirmity too much. This publicity can not be avoided. The benefit derived from their use abundantly counterbalances all the unpleasant notoriety it causes.

INDEX.

Auricle 1
“ Anatomy of 1
“ Blood supply of 3
“ Veins of 4
“ Nerves of 4
“ Diseases of 4
“ Injuries of 4
“ Blood tumor in 5
“ Sebaceous tumor in 7
“ Fibroid tumor of 7
“ Cancers of 8
“ Deformities of 8
“ Gouty 9
“ Frozen 10
“ Erysipelas of 10
“ Eczema of 10
“ “ Acute 13
“ “ Chronic 13
“ “ Moist 13, 15
“ “ Dry 13, 16
“ Blisters behind, in children 19
Atropine in painful ear affections 55, 56, 162
“ in acute Myringitis of 84
Autophonia 82
Abscess in Mem 103
“ Mastoid 244
“ Trephining in 246
Annulus Tympanicus 65
Anvil 120

Blisters in children 19
“ on Mem. Tymp 103
Bodies, foreign 35
Balloon 136

Climate, change of, in Aural Catarrh 202
Cerumen, accumulation of 29
Cone of light 70

Cells, Mastoid........243, 122
" " Acute inflammation in........243
Cushion, mucous, in children........128
Catheter, Eustachian........136
" Introduction of........138
Catarrh, Tubal........174
" Aural........164
" Dry........174
" Moist and dry........174
" Aural relapses in........181
" " Paracentesis in........193
" " Treatment of throat in........195
Caries of temporal bone........240
Cholesteatoma........210

Deposits, calcareous........94, 171
Drum........113
" Chronic inflammation of........163
Drum and Tube, Catarrhal inflammation of........164
Douche, nasal........200
" Objections to its use........200
Drums, infantile, purulent inflammation in........208
Dangers of inflammatory diseases of Drum and Meatus........238
Drum, serum in........236
" Artificial........249
" " Cases of........250
Deafness, nervous........262
" from Cerebro-Spinal Meningitis........270
" Tone........273
" Cerebral........271
Disease, Meniere's........269
" Aural, blunts the mental powers........281

Eczema of Auricle........10
" Acute and Chronic........13
" Dry........13, 16
" Moist........13, 15
Erysipelas of Auricle........10
Electricity in Aural affections........277
Exostosis........61
Examination, method of........25
Emphysema........145
Ear-trumpets........283

Folds, anterior and interior........70
Furuncles........43
" Preventives for........48

Gargles 198
" Method of using 198
Growths, Polypous 203
" Malignant 210

Hammer 118
Handle of Malleus 119
Hearing double 272

Illumination of Meatus 23
Incus 120
" Long and short process of 120
Inflation 135
" Modus operandi of 137
" General remark on 142
" Illustrated 143
" Accidents in 145
Inflation, Valsalvian method 147
" Politzer's method 148
" Effects of 150
" Indications for 151
Injection of fluid into Tympanum 189

Light spot 70
Labyrinth 255
" Anatomy of 255
" Bony 255
" Membranous 258
" Diseases of 261
" Inflammatory affections of 264

Meatus Audit. external 19
" Anatomy of 19
" Examination of 22
" " Method of 25
" Illumination of by reflection 23
" Wax in 28
" " Accumulation in 29
" Dryness of 29
" Foreign bodies in 35
Mirror 28
" with head-band 42
Membrana Tympani 64
" Anatomy of 64
" " Minute 67
" Examination of 71
" Land-marks of 71
" Anomalies of, in health 72

Membrana, injuries of 74
Membrane, diseases of 76
" Inflammation of 80
" " Acute 80
" " Chronic 91
" " Traumatic 80
" Calcareous deposits in 94
" Opacification of 96
" Irregularities in 97
" Hernial protrusions of 99
" General remarks on 100
Myringitis, acute 80
" cases of 86
" Traumatic 80
" Chronic 91
" General remarks on 89
" Parasitica 90
Membrane, ulceration and perforation of 92
" Invisible perforations of 93
Myringotomy 107
Myringectomy 107
" Indications for 107
Malleus 118
Manubrium 119
Muscle, Tensor Tympani 130
" Stapedius 131
" Pharyngo-tubal 131, 132
" Levator Palati 133
" Palato-pharyngeus 134
Membrana Tympani, art 249
" " cases of 250
" " General remarks on 253
Mind blunted by Aural disease 281
Membrane, pulsations in 102
" Movements of 101
Meatus, external, Epithelioma of 63
" Hyperostosis in 63
" Exostosis in 61
" Narrowing of 60
" Boils in 42

Noises in the Ear 32
" Pulsating and cracking 274
Necrosis of Temporal Bone 240
Nerve, Facial 116
" Chorda Tympani 116, 122
" Auditory 260

Otitis Diffusa ... 49
" Parasitica ... 59
" Circumscripta ... 42
" Externa ... 42
" Media Acute and Catarrhal ... 152
Otorrhœa ... 52, 211
" Simple ... 212
" Tympanic ... 218
" Remarks on ... 225
Ossicula Auditus ... 118
Otalgia ... 279
" Atropine in ... 280

Pockets, anterior and posterior ... 69
Perforations of Membrana ... 92, 248
" Invisible ... 93
Pulsations in Membrana ... 102
Paracentesis of Membrana ... 103
" Indications for ... 103, 160
Process, Short ... 119
" Long ... 119
Pump, compression ... 146
Pharyngitis, Follicular ... 172, 177
Pharyngoscopy ... 196
Polypi, Aural ... 226
" Snare for ... 233
Paracusis Duplicata ... 272

Rhinoscopy ... 196

Syringing, how to do it ... 26
" Why it is done ... 28
" Nervous impression from ... 27
Syringe, hard rubber ear ... 27
" Catarrhal ... 199
Stapes ... 121
Sound, conduction of through the bones ... 181
Serum in Drum ... 236
Saccule ... 260
Snare, Polypous ... 233

Tumor, Blood ... 5
" Sebaceous ... 7
" Fibroid ... 7
" Epithelioma ... 63
" Malignant ... 210
Tube, Eustachian ... 124
" Ausculting ... 135

Tenotomy of Tensor Tymp........ 109
Tympanum........ 113
  " Anatomy of........ 113
  " Infantile........ 127
  " Mucous Cushion of........ 128
  " Diseases of........ 151
Tube, Eustachian, diseases of........ 151
Tympanum and Tube, acute inflammation of........ 153
  " " " " Paracentesis in........ 160
  " " " Catarrhal inflammation of........ 164
  " " " Injection of fluids in........ 189
Tympanum, chronic inflammation of........ 163
Tube, forcible dilatation of........ 187
Tonsils, Hypertrophied........ 203
  " " Treatment of........ 204
  " Amputation of........ 205
  " Deafness from, case of........ 206
Tympanum, serum in........ 236
Trumpets, ear........ 283

Umbo........ 70
Ulceration and perforation of Membrane........ 92

Voice, loss of........ 282
Vestibule........ 256

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